Peaslee (E.R.)

A

SYNOPSIS

OF THE

COURSE OF LECTURES

ON

GENERAL AND HUMAN PHYSIOLOGY,

IN THE

New-Hampshire Medical Institution,

(DARTMOUTH COLLEGE.)

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TO THE MEDICAL CLASSES OF DARTMOUTH AND BOWDOIN COLLEGES.

GENTLEMEN,

Since the limited time allotted to my departments does not allow a full discussion of all the topics included in the course I had prepared in Physiology, the following Synopsis of the 1st part of it (including General Physiology and the Organic Functions) has been compiled for your use; in order to make apparent the natural relations of the pretermitted subjects, and the order in which they should be investigated, as your future leisure may permit.

I uniformly devote more time to the Animal Functions; and therefore have not extended this compilation over that part of the course. E. R. P.

PROF. PEASLEE'S SYNOPSIS OF LECTURES,

ON

GENERAL AND HUMAN PHYSIOLOGY.

PART 1st. GENERAL PHYSIOLOGY.

PRELIMINARY CONSIDERATIONS.

But two classes of objects in the material world—organized and non-organized. Object of the Natural Sciences—do. of Biology—define the term. Its subdivisions, Physiology and Pathology—define them.

The vast extent of the field presented to the Physiologist—the subdivisions of Physiology—General and Special—Vegetable—Animal—Comparative. Psychology, a division of Physiology.

Physiology, the basis of Pathology—is indispensable to an acquaintance with Medical Science---A safeguard against the various forms of Quackery.

Hygiene---Definition—Relation to Physiology.

Subdivisions of Pathology—General and Special—Nosology—Aetiology—Semeiology—Diagnosis—Prognosis—these constituting the Science of *Disease.*

Relation of Pathological Anatomy to Pathology.

Therapeutics—define—not a branch of Pathology—General Therapeutics—Special do. Define the term "Indication."

The Science of Medicine includes what? The *Institutes* of Medicine; define the term. *Rational* Medicine, do.

Schedule showing the order in which the various branches in the curriculum of Medical studies should be pursued.

General plan of the course of Lectures which follows.

ORGANIZATION.

Define the term—Distinction between organized and non-organized bodies—*External form*—not always distinctive—*Relative solidity*—latter increases with age—Great degree of softness essential to the highest functions—*Organized bodies* are said to *resist chemical action (decomposition)*—this not the fact; are affected by it more rapidly than most inorganic bodies—The true distinction in this respect. Neither organized nor non-organized bodies have any inherent tendency to decomposition. Establishments at Bordeaux, &c., prove this. Both are acted upon by external agents.

Chemical composition of organized and non-organized bodies differs—this one reason of their more ready decomposition.

Inorganic matter is *homogeneous*—organized bodies not so. Individuality of former resides in each molecule.

Still, only seventeen of the 55 Chemical elements are found in the whole vegetable and animal worlds. Composition of Cellulose, the basis of vegetable structures. Do. of Proteine the basis of animal tissues. Vegetables may derive the elements entering into their composition from inorganic matter—animals cannot. Vegetables moreover lay up a store of nutriment for animals in the form of deposites and secretions; without which animals would perish.

Organized bodies manifest vital phenomena; non-organized not so. Distinguish between Properties, Forces, and Phenomena.

LIFE.

The usual definition—explains nothing. We know nothing of its essence; must infer its nature from its phenomena. Distinguish between Vitality and Life.

What is a law in natural science? Laws do not *govern* or *produce* phenomena. The laws the Physiologist developes are no less absolute than others—e. g., those of Astronomy. How are they to be discovered? Each science has its ultimate facts—define. Physiology has its own. Illustrated.

THE VITAL STMULI.

The action of certain external agents necessary to the manifestation of Life—specify them—Specific effects of Oxygen as a vital stimulus—do. of Nutriment—of Water—of Heat—Light—Electricity. Physiological inferences from preceding facts. Pathological effects from abnormal action of each of the vital stimuli. Therapeutical indications in each case.

The true *vital* actions must not be mistaken for others common to living bodies and to inorganic matter. Must exclude *first* the *purely physical* actions—*second*, the *purely Chemical* actions.

1st. NON-VITAL ACTIONS IN LIVING BODIES,

A. The *physical*—Endosmosis—Capillary Attraction—Elasticity.

B. The *chemical* actions—manifested by vegetable cell-germs—also in animal and vegetable excretions—in Digestion, &c. &c.

Pathological effects of abnormal action of the *physical* forces—Therapeutical indications. Rule for the administration of Saline Diuretics and Cathartics. Singular effects of Sulphuric Acid on Endosmosis—do. of Hydrochloric Acid.

Pathological effects of excessive or diminished action of the *Chemical* force, e. g., Indigestion, Vesical Calculi, &c. Therapeutical Indications.

2ND. PECULIAR AND VITAL ACTIONS IN LIVING BODIES.

Two phases of Vital Force—1st, Organic, or Plastic Force—manifested by all living Bodies. 2d, Dynamic Force—manifested only by animals.

A. *Organic Force*—(cell-life)—the only phase of Vital Force manifested by the Vegetable World. Its objects, Nutrition and Reproduction. Is manifested by *cells*—We are unconscious of its operations.

Organic Force manifests itself in five ways—1st, in developing cell-wall—2nd, separating contained fluid from Blastema—3d, producing other endogenous or exogenous cells—4th, transformation of cells into the tissues—5th, Germinal vesicle determining the type of the future being. Shall Ciliary Motion be added?

No one species ever developes another—Equivocal Generation—Even a *new* species appearing to be produced under peculiar circumstances, no proof of it.

B. *Dynamic Force*—developed by *organs*, (Nervous and Muscular Systems,)—We are conscious of its effects—Is of two kinds, Muscular and Sensory. Its results generally are *objective*—those of the Organic Force, *subjective*.

Yet the Organic and Dynamic Forces are mutually dependent—the latter affording the conditions for the exertion of the former.

Only the Nervous Tissue and the Muscular, (striated and non-striated,) manifest Dynamic Force. Repose must follow Dynamic exertions—not so Organic, unless excessive. Organic precedes Dynamic Force in order of developement. Give order of developement of Dynamic Force. Sensation is last—Does Fœtus in Utero possess it?

Physiological and Pathological relations of the Organic and Dynamic Forces. Therapeutical Indications. Stimulants and Narcotics affect the Dynamic Force; Tonics and Alteratives, the Organic. Caution in the use of Stimulants—do. of Narcotics for infants, why? Action of Digitalis—Cantharides—Ergot—Aloes—Strychnia, &c.

Recapitulation of preceding views.

Tabular Classification of the three kinds of Forces manifested in Living Animals.

VITAL PROPERTIES.

Define the term---1st, Irritability---define---common to plants and animals---2d, Contractility---define---is a property of muscular fibre. *Mobility*---is common to plants and animals---its relations to Contractility. Distinguish between vital and mere *physical* Contractility. 3d, Sensibility---define---depends on nervous system. Sympathy. (Vital Affinity and Vivification---Paine.)

Pathological states of the above properties. Irritation. Spasm---Paralysis. Hyperæsthesia---Anæsthesia, &c.

ANIMAL PHYSIOLOGY.

PRELIMINARY TOPICS.

Classification of Animal Kingdom—General characters of each class—Place of Man in the Animal Scale—Did the whole race originate from the same parentage ?

STRUCTURE OF ANIMALS.

Solids and fluids—their ratio in the human body. Fluids diminish as age increases. *Fluids* divided into two classes—Blood, including Chyle and Lymph, (*incipient* Blood) ; and the Secretions. Water constitutes the greatest portion of them all—forms about four-fifths of adult human body—Humoralism. The *Solids* are the aggregate of the Organs (define)—the Tissues, of the Proximate Elements—and these, of the simple Chemical Elements.

A. Chemical (simple) Elements. But seventeen found in the whole Animal Series. But fifteen enter into the structure of the human body—Specify them. Some add Iodine, Bromine and Arsenick. The four most abundant, and found in most of the Organs.

Whence are each of these fifteen elements derived ? (See Digestion.)

Organs and Tissues in which these Elements are found in the human body : 1. Sulphur—always with Albumen and Fibrine—also in hair and nails—as *Sulphuric Acid* with bases in urine, and Lime, in Chondrine. Pathological Relations. 2. Phosphorus—in Albumen and Fibrine—forms one-thirtieth of solids in brain—as *Phosphoric Acid* with Lime in bones—Pathological Relations—Spontaneous Combustion, as explained by Treviranus. 3. Chlorine—in form of *Hydrochloric Acid*, in gastric fluid—Chloride of Sodium and Potassium in blood and bile—Chlorine compounds in milk, saliva, Synovial fluid, urine and cutaneous perspiration. 4. Sodium—always as *Soda*, (Carbonate, Phosphate, Sulphate, Hydrochlorate and Lactate,) in various fluids, e. g. blood, mucus, saliva, bile, milk ; in muscle and bone. 5. Potassium—always as *Potassa*—very minute quantity—much more abundant in plants than animals—Hydrochlorate in the blood, bile, sweat, milk, urine—The Phosphate, in the brain. 5. Calcium—always as *Lime*—Carbonate and Phosphate, largely in the bones—sparingly in the muscles and brain. 7. Magnesium—always as *Magnesia*—the Phosphate in milk, blood, and the brain—and in bones. 8. Silicon—always as *Silica*—very sparingly in hair—in urine—abounds in plants. 9. Iron—in blood of all red-blooded animals, and pigmentum nigrum—traces of some of its salts in the gastric fluid (Kane)—

its relations to respiration ; Liebig's Theory (See Respiration.) 10. Manganese—a mere trace in hair. 11. Fluorine—Fluoride of Calcium in very small quantities in human bones, (Von Bibra.)

By what Organs are these 15 elements respectively eliminated from the human body, in the metamorphosis of the tissues? (See Secretion.)

Tabular view of the tissues and organs in which each of the 15 elements are found in the human body, and the kind of force with which they are associated.

B. Proximate (compound) Elements. 1. Proteine compounds (quarternary) Albumen, Caseine, and Fibrine—Hæmatosine and Globuline—2d, Gelatinous compounds—3d, Ternary compounds—Elaine, Stearine, and Margarine---4th, *Secondary* compounds.

1st. PROTEINE COMPOUNDS.

Remarks on Proteine, the assumed compound radical of this class —its chemical composition—easy decomposition of all its compounds—why? Its importance as the basis of all animal tissues —The Binoxide of Proteine—The Tritoxide—forms much of the "buffy coat" in Inflammations—Alkalies dissolve it—Pathological inference—Proteine always combined with Sulphur or Phosphorus or both, in the Proteine compounds—The latter found (except Caseine) in their simplest state in the blood. All the Proteine compounds derived originally from Vegetables, e. g. *Vegetable* Albumen, Caseine and Fibrine.

A. *Albumen*—two varieties, Ovalbumen and Seralbumen—Their Formulæ and combining numbers; showing their relation to Proteine—two forms of Albumen, soluble (fluid) and insoluble (solid).

Chemical relations of Albumen to Mineral Acids, (except Phosphoric)—to Vegetable Acids (except Tannic)—to Alkalies, (exists in blood serum as Albuminate of Soda)—to Metals—Bichloride of Mercury—The Albumen of one egg neutralizes 4 grains of it —to Alcohol—Effects seen in wet preparations of brain, &c.—to Creasote—Phosphate of Lime—Acetate of Lead—should not be applied to ulcerations of the Cornea.

Other Phosphates and Sulphates found in Seralbumen—also Chloride of Sodium.

Physiological relations of Albumen—same to animals as that of starch to vegetables—the *starting point* of all animal tissues—is changed into fibrine before becoming organizable. Derived originally from the Vegetable kingdom—combined with starch and gluten usually in vegetables—in what part of them found? Why is cabbage a proper article of diet in Diabetes?

In what tissues and organs is solid Albumen found normally in the Human Body? Associated with sensory Dynamic Force.

Fluid Albumen normally found in the blood only (Lymph and Chyle) and serous secretions, and humors of the eye—In blood, acts endosmotically on all watery solutions in contact with the vessels.

Pathological relations of Albumen—Solid Albumen forms some malignant growths--Indications. *Fluid* Albumen in dejections in Asiatic Cholera; and those produced by Hydragogue Cathartics—in Pus—in morbid serous effusions—in Urine (Bright's disease, &c.). Action of Mineral Acids in colliquative discharges.

How detect the presence of fluid Albumen; e. g., in Urine.

Effects of certain classes of Remedies explained--The Albumen in the Blood is probably not acted upon by Chemical Agents, while the Blood is yet circulating. The action of Astringents—Styptics--Mineral tonics--Arsenic--Bichloride of Mercury--Alcohol—Creasote.

B. *Caseine*—Found, in animals, in milk only—milk contains no Albumen—Chemical composition like that of Albumen except it contains no Phosphorus.

Chemical relations of Caseine--identical with those of Albumen, except, 1st is *not* coagulated by Heat—2nd *is* coagulated by *all* acids and by Alcohol (Kane). Surpasses Albumen in rendering soluble the Phosphates of Lime and Magnesia.

Caseine *peculiar* in coagulating from contact of certain membranes —Various explanations.

Physiological relations--Caseine always converted into Albumen in the stomach of the young Mammal; then into Fibrine.

C. *Fibrine*—the only *organizable* material from which all animal tissues are formed--Albumen and Caseine (both non-organizable) are converted into this before forming a part of the living body.

Chemical composition--identical with Ovalbumen (Mulder)—differs slightly from this (Dumas)—Combining number.

Two forms, Fluid and Solid—*Fluid* exists only in living Blood (Lymph and Chyle) and exudations from it, e. g., in Inflammation. Is *solid* in every other case, even in the blood after it is taken from the vessels. Exists most abundantly in muscle. Is associated with motor Dynamic force.

Chemical relations very important—unlike Albumen is, then, coagulated by mere *rest*—on this spontaneous action depends the coagulation of the blood—Fibrine kept fluid by Caustic Potash, Sulphate of Soda, Nitrate and Carbonate of Potassa, Chloride of Sodium, Phosphoric and Acetic Acids. Fibrine inferior to Albumen in uniting with Phosphates of Lime and Magnesia.

Physiological relations of Fibrine—Difference between coagulum of Albumen and of Fibrine—best seen in "buffy coat" and inflammatory exudations, why? Describe the appearance of the *fibrillation* in these cases—Inflammation not essential to fibrillation--Membrane lining egg-shell—chorion of human embryo.

"Coagulable Lymph" is what? Synonymes.

Coagulation of Fibrine a vital act—Fibrillation the *first step;* organization succeeds—Fibrine is then Albumen *vitalized.*

Fibrillation in a fibrinous exudation cannot go on to Organization, unless the exudation remains in contact with the living tissues. Circumstances in the living tissues favoring the process, and the subsequent Organization; 1st, thin layer of exudation; why? 2d, A plane surface—3d, Perfect rest of that surface.

Table showing the relative chemical composition of muscular fibre, False membrane, and Mucus.

Pathological relations of Fibrine—*Fluid,*found in Inflammatory exudations; and some dropsical effusions; *Solid,* in heart and large vessels after death,and in false membranes—and in some tumors. Action of alkalies to prevent false membranes—of Calomel do. do. &c.—Why false membranes most common on serous surfaces? Why sometimes on mucous surfaces? Croup (pseudo-membranous Laryngitis).

Three causes preventing coagulation of blood after death, 1st, Ferments, e. g., malignant Typhus, Glanders, &c., 2d, Retained excretions, &c,—Scurvy and Purpura—Indications in these diseases—Asphyxia—Indications. 3d, Violent shocks, &c., e. g., Lightning—Blows on epigastrium, &c.

Why does not coagulation ensue in these cases?

Singular cases of delayed coagulation, in disease.

Tabular view of the tissues and organs in which Albumen and Fibrine are found; both in the solid and the fluid state, and both in health and disease.

Globuline and Hæmatosine. (See Circulation.)

2ND. GELATINOUS CONSTITUENTS OF ANIMAL STRUCTURES.

Probably derived from Proteine compounds—Found in animals alone--Are but two; Gelatine and Chondrine.

1st. *Gelatine*--Its chemical composition, and combining number—Of less easy decomposition than Proteine compounds—two forms, solid and fluid—The fluid does not exist *as such* in the human body; is, like Proteine, obtained artificially, how? Does exist naturally in some fishes. Its two commercial forms.

Chemical relations of Gelatine--to warm water—dilute acids, and alkalies—to Alcohol and Ether--to Tannic acid—Use in the arts—Test for the presence of Gelatine in solution—Gelatine is of neutral reaction--contains Phosphate of Lime, &c.

Physiological relations of Gelatine--Is abundant in the tissues of young animals--Is derived probably from Albumen—Herbivorous animals must derive it from vegetable Albumen, Caseine, &c.---Its power of Gelatinizing—explain---Jellies are what? In what tissues is Gelatine found in the human body? Is generally associated with mere *physical* force. viz. Elasticity, &c.

Action of Tannic acid as an Astringent.

2d. *Chondrine*---In chemical composition approaches nearer the Proteine compounds than does Gelatine---Its formula and combining number---More easily decomposed than Gelatine. Seems to be an intermediate stage in the conversion of the Proteine compounds into Gelatine; explain.

Chemical relations of Chondrine---Similar, generally, to those of Gelatine; *but*, it is *not* precipitated by Tannic acid; and is precipitated by Acetic acid, Alum, Acetate of Lead and Proto-Sulphate of Iron.

Physiological relations of Chondrine---Is found in all cellular cartilages, and there alone, whether temporary or persistent---*not* found in fibro-cartilages---When temporary cartilages are converted into bone, their Chondrine is converted into Gelatine. Analogy of Chondrine in animals to Sclerogen in plants.

Why is Chondrine replaced by Gelatine in the bones?

3d. TERNARY COMPOUNDS (FATTY CONSTITUENTS) OF ANIMAL BODIES.

Are three; Elaine, Stearine and Margarine—*Elaine* is fluid (above 65 deg.) and holds the others in solution---The three thus combined form most animal *fats*---Human fat contains no Stearine. Relation to these of the compound radical, Glycerine. The formation of soap.

Formula of Margarine---is soluble in Alcohol and Ether---Do. of Elaine.

Physiological relations of these compounds. An animal supplied with either of the three may produce the others.

Three uses of the fat consumed in our food. 1st. As fuel for the respiratory process, (See Digestion.) 2d. Is deposited as adipose tissue. 3d. Enters into composition of certain organs. In the brain it constitutes about one-third of the whole solid matter; but the fat of the brain is a *nitrogenized* compound, as the three compounds above, and adipose tissue, are not. Abundance of red fat (Cerebrol) in the vesicular matter of the brain. Emaciation produced by intense action of the brain; or by deficient sleep.

4th. SECONDARY ORGANIC COMPOUNDS.

Seven may be mentioned---Urea, Uric (formerly Lithic) acid, and Cholesterine (see Secretion), Ptyaline, Pepsine (see Digestion), Sugar of milk, Lactic acid (see Secretion).

Tabular view of the preceding Elements of Animal Structures, associating each with the kind of force, whether vital or otherwise, of which it is the instrument.

THE TISSUES FORMING THE ORGANS OF ANIMAL BODIES.

HISTOLOGY.

Define---Classification of the tissues.

A. *Elementary Tissues*---1. Simple membrane, and its modifications; Epithelium---Walls of Primordial cells, and those of pigment and fat-cells, &c. 2. White Fibrous tissue. 3. Yellow fibrous (Elastic) tissue. 4. Osseous tissue, and its modifications. Physical properties associated with each of these four tissues.

B. *Compound Tissues.* 1. *Binary;* Cartilage---Muscular fibre---Nerve tubes---Areolar tissue---Fibrous tissue (so called) e. g., fibrous membranes, &c.

2. *Ternary:* Mucous membrane—Serous and Synovial membranes—Skin—Fibro-cartilage. 'Vascular tissue,' and 'Glandular tissue,' are not distinctive phrases. When are tissues termed "Extra-vascular."

The characteristics and peculiar functions, vital or otherwise, of each of the above tissues.

HISTOGENY.

Define—All the tissues (except simple membrane) formed originally from Cells; hence, Cytogeny, or cell-development, is first to be considered. The discoveries of Schwann—modified by recent investigations.

Two ways (or three) in which cells originate in animals—The Cytoblast; Nucleus; Nucleolus; Cytoblastema or Blastema, &c.

2. How are these cells *transformed* to form the various tissues? Doubts as to the *absoluteness* of this law—The best authorities at the present time, respecting the formation of each of the compound tissues before mentioned, and in their order.

THE ANIMAL ORGANS FORMED FROM THE PRECEDING TISSUES.

Define the word 'Organ'—do. 'Apparatus'—do. 'Morphology'—Classify the organs in the human body.

Development—define—The three layers of the Germinal membrane, Serous, Vascular, and Mucous—The organs developed in each—explain at length. Is the Nervous or the Vascular system first developed?

Trace the development of the different parts of the Nervous system. Do. do. do. Vascular system. Do. do. do. Alimentary, and Urino-genital Apparatus.

FLUIDS IN ANIMAL BODIES.

A. *Blood*, (See Circulation), Chyle and Lymph, (See Digestion and Absorption.)

B. *Other Fluids*, (See Secretion)—Humoralism and Solidism. (p. 6.)

CONCLUDING REMARKS.

On *Vitalism*—The *Chemical* doctrines—The *Chemico-Vital* Theory. (Consult p. 4 and 5.)

PART II.

SPECIAL (HUMAN) PHYSIOLOGY.

PRELIMINARY TOPICS.

The Functions—define the Phrase. What is *a* function? Three great objects of the functions in man.

Hence three divisions; Nutritive, Reproductive, and Functions of Relation, or Animal Functions. The Nutritive and Reproductive constitute the Organic or Vegetative Functions.

The table below indicates the classification, and the order of considering the Functions, which will be adopted.

The *Organic* functions are manifestations of the *Organic force.* (See p. 5.) But certain Dynamic actions are preliminary to each of them, to afford the necessary conditions for the action of the Organic force. The Animal Functions are manifestations of the Dynamic Force. (p. 5.) Still the Organic force is indirectly essential to these. Illustrate the mutual relation of the Organic and Dynamic functions. (p. 5.)

- **Classification of the Functions of the Human Body.**
  - **Organic Functions.**
    - Nutritive Functions.
      - Functions of Hæmatosis.
        - Digestion.
        - Absorption.
        - Circulation.
        - Respiration.
      - Nutrition and Assimilation.
      - Secretion.
    - Reproduction.
  - **Animal Functions.**
    - Motion.
      - Reflex.
      - Instinctive.
      - Voluntary.
    - Sympathy of organs and parts.
    - Sensation.
      - External.
      - Internal.

CLASS 1st. ORGANIC FUNCTIONS.

A. NUTRITIVE FUNCTIONS.

Are two subdivisions, Functions of Hæmatosis, (Sanguification); and of Nutrition proper, including also Secretion. The former subdivision includes what? (Table p. 12.)

I. FUNCTION OF DIGESTION.

Define the word—Digestion peculiar to Animals; Absorption being the first Nutritive function in Vegetables.

The organs indispensable to Digestion are a *Stomach* affording a Gastric fluid, and a *Liver* affording Bile. Relation of these two organs in the lowest animals.

Morphology of the Digestive Apparatus in the whole Animal series. Infer—is man naturally *carnivorous*, exclusively or in part; or a *phytophagous* animal?

Proper Digestive *organs* in man are the Stomach, Duodenum, and Liver. True function of the parts of the Digestive *Apparatus* above and below these.

Peculiar structure of the Stomach and small Intestine.

A. *Dynamic actions* preliminary to Digestion. 1st, Mastication, securin galso Insalivation—2d, Deglutition—3d, Dynamic motions of Stomach itself and Duodenum. Explain the importance of each. Physiological inferences.

The facts observed by Dr. Beaumont respecting the formation of Chyme in the Stomach. Infer—eat slowly—let the food be of proper temperature.

B. *Secretions* essential to Digestion. Saliva; Gastric Fluid; Bile; Pancreatic Fluid; Mucus.

1st, *Saliva*—Quantity in 24 hours. Has alkaline reaction; (buccal Mucus is acid). Its chemical composition (Dr. Wright). The salts contained in it. Ptyaline—its properties.

Microscopical appearance of Saliva. Donne's experiments.

Physiological relations of Saliva. 1. Dissolves Proteine compounds, and Mucus (Enderlin)—Converts Starch into Sugar—how? Absorbs Oxygen in abundance—Other effects (Dr. Wright).

Pathological relations of Saliva. Is *acid* in acute Rheumatism, Irritation and Inflammation of the Stomach, Mercurial Salivation, Aphthæ, Pleuritis, Encephalitis, Intermittent Fever, Amenorrhœa and other uterine affections (Donne). Contains less water than usual in Inflammations. Tartar on the Teeth formed from its Phosphate of Lime and Magnesia. It may also become bilious, fatty, or sweet.

Effects of habitually ejecting the Saliva. Its importance in acid states of the Stomach. Are sedentary men more liable to Dyspepsia than females equally sedentary?

2d, *The Gastric Fluid*—Its *physical* properties—Chemical composition—Contains a trace of Iron (Simon)—Has an acid reaction, from the presence of Hydrochloric acid (Dunglinson) and Lactic acid (Dr. R. D. Thomson). The former acid is derived from common salt (B. Jones). Some assert a *Chloride*, and not *Hydrochloric acid*, exists in Gastric fluid. Does *acetic* acid also exist in Gastric fluid? MM. Bernard and Barreswil deny the existence of the bi-phosphate of Lime, &c.; but they experimented on dogs.

The Gastric Fluid contains an organic compound called Pepsine. (p. 10.) This is, like Ptyaline, analogous to Albumen. Both a Hydrochlorate and an Acetate of Pepsine exist in Gastric Fluid. Remarkable solvent effects of these two salts on the Proteine compounds; how explained?

Physiological relations of the Gastric Fluid. Its precise effects, in forming Chyme, upon 1st, the Proteine compounds in our food; 2d, on Gelatine; 3d, on Gum and Sugar; 4th, Fatty matters; and lastly, resins, woody fibre, elastic tissue, &c., &c. The precise portion of the effects just alluded to, produced by the *acids* in the G. Fluid—do. do. do. by the *Pepsine*. Effects of rendering this fluid alkaline (Barreswil). The *acids dissolve* the food; how does the *Pepsine* produce its effects? (Wagner, &c.)

The Gastric Fluid is not secreted while the stomach is empty. Its quantity proportional to the wants of the body; *not* to the amount of food taken. Inference. Effects of stimulating condiments. Effects of over-eating not at once developed. Temperature of stomach must be 100^0 that Digestion may occur. Effects of iced articles of diet, &c.

The Gastric fluid possesses antiseptic properties. It is *produced* by the vital force—itself mainly *producing*, apparently, *chemical* effects. *Artificial* digestion with *natural* Gastric Fluid succeeds; not so, with *artificial Gastric fluid*. Experiments of Wassmann, Wagner, &c. Relations of Saliva, Gastric fluid, and Pancreatic fluid, (Barreswil).

Chyme—its properties, physical, and chemical. Action of the Pylorus. How long does the food remain in the Stomach before being converted into Chyme? Table showing the difference in digestibility of different articles of diet, (Beaumont).

Pathological relations of the Gastric fluid. Effects of an *excessively* acid state of it. What acids most frequently generated in disease; and the cause of each. Indications. Causes of an *alkaline* state of the Gastric Fluid. Indications. Effects of an habitual use of Alkalies in excess. Bile mixed with the Gastric Fluid, in the stomach, impairs its digestive powers,(Pappenheim)—should act *after* the Gastric fluid.

Dyspepsia; Apepsia or Indigestion—owing to a multiplicity of causes. The true cause is to be ascertained in each case. Food itself produces irritation of stomach, &c., if Gastric fluid is not secreted, e. g. in fevers, &c. Gas sometimes secreted in great quantities in stomachic disease; its composition, (Simon).

Action of Hydrochlorate of Iron, in atonic states of the stomach—of other tonics, &c., &c.

3d, *The Bile*—Its physical properties—Chemical composition is very complex. (See Secretion.) Has an alkaline reaction, from the Soda it contains. Hence Chyle is *alkaline*, while Chyme is *acid*. Sources of the Bile—Quantity during 24 hours.

Are three essential components of the Bile, 1st, alkaline elements—2d, the resinous—3d, the Calorific. Explain.

Physiological relations of Bile. 1st, The *Alkaline* portion renders soluble the fat in the Chyme, and converts the latter into Chyle. 2d, The *Resinous*, excites the Dynamic (peristaltic) actions of the Intestines; and is discharged in the faeces—(the other two elements are *reabsorbed*)—3d, The *Calorific* elements (fat, sugar, &c.) conduce to maintain the animal heat; how? (p. 16.) Bile is indispensable to Chylification, as shown by Schwann—hence found in all animals. Unlike the Gastric fluid, Bile is *constantly* secreted. Does not enter Duodenum while empty. Use of the Gall Bladder. Why not found in many of the Herbivora?

Chyle—its properties—has never been chemically analyzed. Comparative analysis of Lymph and Chyle in lower animals (Dr. G. O. Rees). Do. do. of Chyme and Chyle of the horse (Tiedemann and Gmelin). Three kinds of contents of the Duodenum; the residual matter in the centre of the canal.

Pathological relations of the Bile. In Cholera it contains an excess of Resin, (Hermann)—Remarkable diminution of this element in fatty degeneration of the Liver, (Thenard). In Phthisis it contains very little fat, (Chevreul). In icterus the Biliverdin (coloring matter) is enormously increased, (Scherer). Chololithi are composed principally of Cholesterine.

Effects of non-secretion of Bile on Digestion: on alimentary canal. Other effects (see Secretion). Substitution of ox-gall in some cases. What are Cholagogues? Action of Alkalies in Icterus, Duodenitis, &c. Pathological relations of Liver and Stomach; to be remembered in cases of disordered digestion.

4th, *Pancreatic fluid*—Similar to Saliva in physical and chemical properties; and in being most abundant in the Herbivora. Enters the Duodenum with the Bile. Is it more than an accessary Salivary secretion?

5th, Intestinal Mucus—by what secreted? Physical properties—Chemical do.—Has an *acid* reaction—Microscopic appearance—Chemical analysis of (pulmonary) mucus, (Nasse).

Physiological relations. Mucus is secreted on whole alimentary canal; hence mixed with food, chyme, chyle, and residual matters. Probably aids the Gastric fluid in some degree. Is not the latter a more highly elaborated mucus, from the peculiar Gastric follicles? The mucus also shields the membrane. Is mostly if not wholly ejected with the fæces.

Functions of the infra-duodenal portions of the alimentary canal in relation to Digestion; and to Defecation. How long is the residual part of the food in passing the whole length of the canal? Defecation a dynamic function (see Reflex motion).

Pathological relations of Mucus—Not always distinguishable from Pus—Both sink in water when pure; intestinal Mucus *always* does. The Microscope will not distinguish them, unless the Mucus be perfectly healthy. But Pus contains Albumen; *healthy* Mucus does not. In Dysentery, intestinal Mucus becomes red (Simon). Is increased in irritation of alimentary canal—Indications. Hydragogues are what—do not merely increase Mucous secretion; what other effects? Opiates diminish it—Effects of this diminution on Digestion, Defecation, &c.

The course of the Chyle from the Duodenum, &c., into the Circulation. (See Absorption.)

REMARKS ON ALIMENT—HUNGER—THIRST.

Our food contains, A. *Nutritive* (Azotized) *Elements;* Proteine and Gelatinous compounds. (p. 7, 9.)

B. *Non-nutritive* (non-azotized) *Elements;* including (I.) Residual (indigestible) matters; woody fibre, resins, &c.; (II.) fat, sugar, &c. *(Calorific Elements.)*

A. The *Nutritive Elements* afford materials for (1st) the original structure of the organism, and its future growth; (2d) for repairing the loss constantly occasioned by the exertion of the Organic force; and the more rapid waste produced by the Dynamic force (in the Nervous and Muscular Systems). Proofs of these two propositions. The quantity needed must be proportionate to the activity of all the functions.

B. (I.) The *Residual* matter, 1st, distends the stomach and alimentary canal—2d, excites their Dynamic actions; then leaves the body, as the fæces. Importance of both these effects. Inference in respect to purely nutritious food. (II.) The *Calorific* Elements (non-nitrogenized) aid in maintaining the animal heat; hence the term. (See also Bile, p. 15.) They do not repair waste; hence will not sustain life, unless the Nutritive Elements be added. Proofs of the preceding assertions. Pure starch, gum, sugar, oil, fat, &c., are merely Calorific. (Fat is in a slight degree nutritive, p. 10.) The Proteine compounds, whether of vegetable or animal origin, are purely nutritive, and indirectly Calorific. In *Carnivorous* animals their *own tissues* finally be-

come *Calorific* elements—explain. Their natural activity secures the necessary Metamorphosis.

In what proportion should the Nutritive and Calorific Elements be combined in the food of adults? (R. D. Thomson.) In food of infants? e. g. milk. Why do children need proportionally more of the nutritive elements; sedentary adults, less? Arrow-root, &c., as an exclusive article of diet for infants.

Alcohol, Ether, and Essential oils (diffusible stimulants) are merely Calorific. Inferences.

The Calorific Elements should have a direct ratio to the amount of oxygen consumed in Respiration; the Nutritive, to the amount of exercise (Dynamic waste). Dietetic Habits of Esquimaux. Alcohol not used in so great excess in tropical climates. Inactivity of natives of ditto, and the corresponding peculiarities of diet; contrasted with those of Arctic regions. We must change our diet, if we change climate—how?

Table showing the proportions of the Nutritive and Calorific elements in some of the most common articles of diet. (R. D. Thompson.) A given quantity of a mixed diet equal to about five times as much purely animal food. Why?

Effects of a deficiency of Calorific elements in our food. Proximate cause of death in starvation (Chossat). In great emaciation, they must be taken if there is no appetite even: why? Must be perfect repose in such cases. Effects of an excess of these elements.

Effects of a deficiency of the Nutritive elements—Do. of an excess of do. No absolute rules as to amount of food required per diem, can be given, why? Estimated daily *average* of solid and liquid aliment. Cornaro's daily allowance for 58 years. Remarkable cases of gluttony.

Our food must contain *inorganic* substances also. Refer to the 15 chemical elements in the human body. (page 10, A.) Specify the kinds of food, and the other sources, whence each element is derived. Neither of these unimportant because existing in small quantity. Analogies in support of this proposition. The necessity of variety in our aliment. No single article, except, perhaps, eggs, and milk, can long sustain life; nor these, in adults.

Water also as indispensable as food, 1st, as a vital stimulus, (p. 4,) 2d, to dissolve gum, sugar, and other soluble substances entering the stomach in our food.

Hunger—the sensation prompting us to take food into the stomach. Its seat—and precise medium. Why located in the stomach? Why so immediately appeased on taking food? Distinguish between Hunger, Artificial appetite, and Morbid Do.

Thirst—the sensation prompting us to drink (water). Where located, and why? Proximate cause of *natural* thirst (explain)—hence best satisfied by water; and invariably thus satisfied by

the lower animals. Artificial thirst—Morbid thirst. Thirst a more imperative sensation than hunger. Inference.

How long can life be sustained without taking water into the stomach? How long without food of any kind? Children perish sooner thus, than adults—the emaciated sooner than the corpulent—why? Remarkable cases of abstinence from food and drink. Reptiles, &c., naturally take food but seldom. e. g. Boa constrictor.

Pathological states of above sensations. Demand for food increased by any *drain* on the economy. e. g. suppuration, lactation, Diabetes, &c. Bulimia—Depraved Appetite—Anorexia. Causes of each—The last produced by mental emotions; by protracted Inanition—Indications. Excessive thirst in febrile diseases, &c.—various causes—Indications. Do. Do. in Cholera—do. after taking salt food, how explained? After taking spiced condiments, &c.

II. FUNCTION OF ABSORPTION.

Structure of the Lymphatic or Absorbent System. Found only in the Vertebrata.

A. Absorption of the Chyle from the Alimentary Canal, by its Lymphatics, called Lacteals. Lymphatics never commence with open extremities—how commence the Lacteals? Where commence, the Stomach having none.

How does the Chyle enter the Lacteals? (Goodsir.) Trace it thence till it becomes mixed with the Blood. Changes it undergoes in its passage. Subsequent changes. How the white corpuscles of Chyle to be accounted for? How the *red*, in the Thoracic duct? Chyle (and Lymph) is *incipient* blood; analogous to the true blood of the white-blooded animals.

Absorption is a *vital* action: Endosmosis not so. (p. 4, A.) The Lacteals *absorb alimentary* materials only; others may enter them by Endosmosis, e. g. medicinal substances. But latter principally enter the veins of stomach and Alimentary canal. Is this a true *absorption?*

But even the Lacteals do not absorb all the alimentary materials which enter the circulation. Water, saccharine solutions, &c., pure albumen and fibrine, may at once enter the veins of the stomach (Bouchardat & Sandras). The fat, and the Proteine compounds not thus disposed of, are absorbed by the Lacteals. Is the above action of the stomachic veins a true absorption, or mere Endosmosis? The analogous vessels *alone* absorb, in the Invertebrata.

B. Absorption from all other free surfaces, by their own Lymphatics. All these Lymphatic vessels contain Lymph—Its properties (p. 15, 3d). Whence its white corpuscles? Proportion of fibrine in Lymph and Chyle. Do. of Albumen and water in do.—Two sources of Lymph. Causes of circulation of Lymph and Chyle.

The Lymphatic an appendage to the Venous system. Why then so completely isolated from the latter, except at the two terminal points of the Lymphatic system? Why no need of the Lymphatic system in the Invertebrata?

Lymphatics of these surfaces, like the Lacteals, *absorb alimentary* materials—1st, Lymph, and 2d, any such material upon those surfaces. Life may be sustained by nutritive baths. These vessels also *admit* water and foreign matters, like the lacteals. Those of skin more superficial than the veins; the reverse true of the lungs and alimentary canal. Inference. Endermic medication.

Probably no medicinal substance deficient in *all* the 15 elements (p. 17) enters the circulation through the Lacteals; nor through the other Lymphatics unless in exceptional cases; the *veins* receiving such materials.

How explain the appearance of pus in the Lymphatics?

C. Appendages to the Absorbent system.

1st, The *spleen*—found only in the Vertebrate animals also. Its supposed function in aid of Hæmatosis (Carpenter). Its office as a "Diverticulum" to the Liver.

2d, The Supra-renal Capsules—probably appendages to the Absorbent system during fœtal Life (See Secretion). Probable function of the Thyroid body. The Thymus—(See Respiration.)

Recapitulation of the principles established in respect to the two preceding functions—and practical applications.

The Chyle and Lymph are converted into Blood on arriving in the capillaries of the lungs. Hæmatology the next topic.

THE VITAL FLUID (BLOOD).

Called sap in vegetables, blood in animals. The distinction of white-blooded and red-blooded animals. Cold-blooded and warm-blooded do.

Average quantity of blood in a healthy adult male—do. do. in a female—ratio of its weight to that of the body—What proportion of the whole amount of blood can be lost at once without fatal results? At what ages is blood most abundant in both sexes? (Lecanu.)

Physical properties of human blood—Its specific gravity; less in the female. Microscopical appearance of blood while circulating. What is the liquor Sanguinis? The two kinds of corpuscles seen floating in it.

Chemical relations of blood—Has an alkaline reaction—The following table shows its complex chemical composition in the two sexes. (Becquerel and Rodier.)

A. Blood of the Male.			B. Blood of the Female.		
Water, - - (average)		779.0	- (average)		791.1
Blood corpuscles, (red) -		141.1	- "		127.2
Albumen, - - -		69.4	- "		70.5
Fibrine, (and White corpuscles)		2.2	- (some say 2)		2.2
Free salts and extractive matters,		6.8	- - -		7.4
Fatty matters,	Seroline, 0.02	1.6	- 0.02	1.62	
	Cholesterine, 0.088		- 0.09		
	Phosphorized fat, 0.488		- 0.464		
	Saponified fat, 1.004		- 1.046		
		1000.1			1000.02

Remarks on above table—Varieties in the above proportions consistent with health. The following is the amount of mineral and saline matters in 1000 parts of the blood of both sexes.

A. In Man. (6.499)		B. In the Female. (7.695)	
Chloride of Sodium, (average)	3.1	- (average)	3.9
Other soluble salts, - -	2.5	- - -	2.9
Phosphates, - -	0.334	- - -	0.354
Iron, - - - -	0.565	- - -	0.541

Difference in composition of Venous and Arterial Blood. (Magnus, Simon, &c.)

Physiological relations of the blood. Is the source of all the solids, and the fluids (except Chyle). The precise uses and functions of each of the preceding constituents.

1st, The *water* in the blood—forms a large part of all the secretions. Is also the vehicle for carrying all the other constituents to the capillaries. (See also p. 4 and 17.)

2d, The *Red* (yellow) *corpuscles*. Their form, and average size. Are mere cells; the cell-wall and the nucleus are composed of Globuline, which differs not much from Proteine compounds. The fluid contents are composed of Hæmatine (formerly Hæmatosine), containing the coloring matter of the blood. Differs from Proteine compounds in excess of Carbon, and has iron combined with it. Its formula. How much iron in the blood of an adult male?

Table showing the forms and sizes of the red corpuscles in the different classes of animals.

The red corpuscles have no apparent relation to the function of nutrition. Facts in support of this assumption. They *have* a *direct* relation to the respiratory process. Proofs. Are of course not found in white-blooded animals. For their relations to the process of respiration see the latter (p. 27). Are instru-

mental in sustaining the animal heat, by producing the metamorphosis of the tissues; how? (See Respiration.) Simon's views of the functions of red corpuscles not defensible.

3d, The *Albumen*—Its properties, &c. (see p. 7, A.) Is the probable source of the Fibrine.

4th, *The Fibrine*—Its properties, &c. (see p. 8, C.) The only *plastic* element in the blood; the solids being formed directly from it. Is increased during last months of pregnancy, why?

5th, *The white* (Lymph) *corpuscles* are directly associated with the fibrine. Some suppose they elaborate it from the albumen. Most abundant in blood of young animals. Exist in blood of all animals; the *red* corpuscles do not. Inference. Their form, and size—latter varies little in the animal series. Their function and that of the red corpuscles inferred from their different positions and movements in the vessels as seen under the microscope. Singular change in these positions, &c., in the capillaries of the lungs. (Wagner.)

6th, *The salts*. Their two-fold uses. Of the uses of the extractive matters, nothing is positively known.

7th, *The Fatty matters*—enter into the composition of the brain, and of the Bile, &c. (p. 10.) How is the iron combined in the Hæmatine? Liebig's views—Mulder's.

The *Coagulation* of the blood—Is a vital act—Its cause (p. 9). What elements constitute the serum? do. Crassamentum? Time necessary for coagulation in health? In what class of diseases does coagulation occur more rapidly? Is least rapid in Inflammations, why? What effects as to the *color* of the clot? How explained? The "buffy coat" is not distinctive of Inflammation. Contains white corpuscles in abundance; and tritoxide of Proteine (Mulder). Its proximate cause. May appear in Chlorosis, Pregnancy, after hemorrhages, &c., why? The "cupped" appearance; explain. Diagrams illustrating the form of the clot in health, in Inflammations, and in Chlorosis. (Dr. Williams.)

PATHOLOGICAL CHANGES IN THE COMPOSITION OF THE BLOOD.

These affect principally the Fibrine and the red (and white) Corpuscles. The Albumen is diminished in Albuminaria (Bright's disease). The salts never vary much from 7 parts in 1000.

1st, A. *Is excess of fibrine* (Hyperinosis) and white corpuscles in all acute Inflammations. Most increased in Pneumonia (and acute Rheumatism). Variation in its amount in different degrees of inflammation. White corpuscles form much of the buffy coat. B. Is a *diminution* of fibrine (Hypinosis) and white corpuscles in idiopathic fevers: in typhoid, is sometimes only 0.9 in 1000 parts.

2d, Is an excess of *red Corpuscles* in Plethora—a diminution in Chlorosis (and other Anæmic states) after Hemorrhages, &c. Action of Iron in such diseases.

3d, The solids generally of the blood are diminished (Spanæmia) in the Cyanoses, (Anæmia, Hydræmia, Schrophulosis, Chlorosis, Scorbutus) and in purpura hemorrhagica, malignant typhus, plague, &c., &c. The specific gravity is often very low in pregnancy; why? Indications.

4th, Foreign substances found in the blood in disease. E. g. Uræmia—Melitæmia—Cholæmia—Piarhæmia—Pyohæmia—Animalculæ sometimes found in diseased blood. (Simon.)

III. FUNCTION OF SANGUIMOTION (CIRCULATION).

A *motion* of the vital fluid is found in all plants and animals; A true *circulation* (explain), only in animals possessing a heart and distinct aerating organs. (p. 25.) Theories held previous to the discovery of the circulation by Harvey; Sanguimotion having been already admitted.

Trace the Circulation from the point to which the Chyle and Lymph have been followed. (p. 16.)

Objects of Sanguimotion are two fold:

1st, To secure the passage of the blood through the capillaries of the respiratory organs (Aeration).

2d, To carry it thence into the general capillaries (Nutrition and Secretion) and back.

Morphology of the Sanguimotory Apparatus in the Animal series. The Sanguimotory Apparatus of man.

1st, *The Heart*—its structure—its development (p. 11)—Capacity of its cavities—its motions—do not *depend* on nervous system; proofs—but are modified by it. Is its Diastole an *active* movement? The *sounds* of the heart; to be studied distinctly from its motions. The cause of each. (Cruveilhier, &c.) Neither the auriculo-ventricular valves nor the pericardium elicit any sound in health.

Pathological modifications of the natural sounds—other abnormal sounds. The diseases indicated by the latter; Endocarditis—Carditis—Pericarditis—Valvular disease—Anæmia—Mere Palpitation—Hypertrophy—Atrophy—Dilatation—Softening, &c., &c.

2d, *The Arteries*—their structure—how modified in the smaller and terminal (explain) arteries? Their contractions and dilatations are affected, but not produced, by the nervous system. Proofs.

3d, *The Capillaries*—their structure—walls contain non-striated muscular fibre. Their size varies in different parts. Table showing their average size in different organs (Muller). The same capillary varies in different circumstances—specify them. Are differently distributed in different organs—illustrate this by diagrams, (Todd & Bowman. &c.) No reason nor necessity for admitting the existence of "vasa serosa."

4th, *The Veins*—their structure—contain some muscular fibres—their aggregate capacity compared with that of the arteries—how explained.

In how long a time may all the blood possibly pass through the heart? Why so rapid a motion of the blood? Hering's experiments. Does not the blood move more rapidly than the motions and capacity of the cavities of the heart can account for?

The *Pulse*—its cause—its velocity, (Dr. Young)—distinguished from its frequency. Table showing the normal frequency of the pulse at different epochs of life. Is more rapid than in Hippocrates' time. Table showing rapidity of pulse in different animals. The frequency of the pulse affected in health by age, sex, [temperament,] mental state, time of day, and state of digestive system, muscular exertion, (position, &c.) (Dr. Guy). Explain at length. Individual peculiarities in respect to character of the pulse. Inferences, physiological and pathological.

Varieties of pulse in disease—1st, *Simple* varieties—Frequent; quick; slow—Regular; irregular; intermittent—Hard; soft—Large (full); small, &c. 2d, *Compound* varieties; Jerking; bounding; vibratory; thrilling; wiry, &c. Some of the above depend on the state of the heart, some on arteries; others on both. Refer each to its cause. In what diseases is the pulse diminished in frequency?

Pathological inferences. Indications.

Physiological relations of the Sanguimotory apparatus. Each part produces its own sanguimotory effects; these four links constituting the whole chain of the Circulation. Each part moreover controls the motion of its own contained blood, provided the part a tergo does the same; explain.

1st, The *Heart*—does not (normally) *alone* propel the blood through the Capillaries into the veins. Explain. Proofs. Its actual muscular force (Carpenter). Precise sanguimotory effects of the Heart. Is merely the *fly-wheel* of Sanguimotion in the animal series; explain. Proofs.

2d, The *arteries*—the sanguimotory powers of the larger class depend more on their physical than their vital properties; explain. Not so with the smaller and *terminal* arteries; they differing in structure and function. These latter supplied with nerves, like the heart, and larger arteries; hence their *tonicity* affected by

even mental emotions. But this tonicity exists independently and may be excited independently of the nervous system. What then the precise sanguimotory powers of the arterial system. Proofs of the views suggested. Effects of increased tonicity of arteries—diminished do.

3d, The *Capillaries*—Their vast physiological and pathological importance—(See objects of sanguimotion, p. 22.) They *alone* normally control the motion of their own contained blood. Proofs from comparative Physiology, &c. This a *vital* force. The *physical* theory of capillary circulation (capillary attraction), and the *chemical*, (Prof. Draper) not tenable. Why do not capillaries and larger vessels alone carry on Sanguimotion in the highest as well as in the lower animals?

The Pulmonary veins, left heart (explain), and arterial system, merely form a canal for carrying the blood from the pulmonary to the general capillaries; the Venous system, right heart, and pulmonary arteries, another to return it to the pulmonary capillaries again.

For effects produced on the Blood in the pulmonary capillaries, see Respiration; do. do. in general capillaries, see Nutrition, and Secretion.

Local determination of blood produced by capillaries alone (and terminal arteries)—Heart can possess no *distributive* power; explain. How reconcile effects of mental emotions on the capillary circulation (e. g. blushing, the draught, &c.) with the idea that they are *not* supplied with nerves of any kind? Positive facts confirming this idea.

Pathological states of the capillary circulation—Congestion; define —Inflammation: how distinguished from Congestion? How the latter from Local determination, (Vascular turgescence.) For other elements of Inflammation, see Nutrition. Effusion; Exudation; Extravasation; define and distinguish. For effects of morbid states of the capillaries and their contents, see Nutrition, Secretion, and Respiration.

4th, The *Veins*—not merely passive conductors of their contents —contractile power proved by their structure and by direct observation of the larger trunks. Other forces aiding their feeble sanguimotory powers. The *respiratory* pulse. The veins liable to congestion, why? Which parts of body most liable, and why? Hence veins liable to enlargement, called Varix; arteries, from different causes, to Aneurism.

Peculiarities of circulation in different parts and organs. That of the brain not entirely different from that of other organs. (Todd & Bowman.)

Recapitulation; and practical applications. Distinguish the *Dynamic* Sanguimotory forces from the organic do. resident in the capillaries.

IV. FUNCTION OF AERATION (RESPIRATION).

Aeration indispensable to life in all plants and animals. Respiration not so. The former alone is an *organic* function; the latter an animal (dynamic) function, affording the conditions for the former in the higher animals. Explain at length.

The objects of Aeration are 1st, The decarbonization of the Blood.
2d, The oxygenation of the Blood.

The aerating structure is essentially the same in all living organisms. Explain.

Morphology of the Aerating Apparatus in the animal series—a *Respiratory* apparatus existing only in *breathing* animals.

The Respiratory apparatus in man; including the aerating do. (pulmonary air cells.) The Larynx — Trachea — Bronchi; Structure of each, &c.

A. RESPIRATION.

The objects of respiration are 1st, (Inspiration), to carry pure atmospheric air to the aerating structure.
2d, (Expiration), to return the air vitiated by its contact with the air cells, to the atmosphere.

Both these (Respiratory) movements subservient to Aeration,

1st, *Inspiration*. The muscles concerned in this movement. How many inspirations per minute (average) in health. Ratio between respiratory movements and the pulse. Modified in disease—Pneumonia—Hysteria—Typhoid fever, &c.

2d, *Expiration*—follows inspiration. Is a passive movement, inspiration is active; explain. Ratio of duration of the two respiratory movements. How modified by disease? *Forced* expiration—muscles concerned in it.

Modifications of the respiratory movements in diseases. Increased—diminished—null, &c. Diseases in which these modifications occur. Inspection of the thorax, &c.

The *sounds* developed by the respiratory movements. Auscultation—define. 1st, *Healthy* respiratory sounds—describe. They vary in different parts of thorax, why? Where is natural Bronchial respiration heard, &c., &c. 2d, Morbid sounds. A. Modifications of natural sounds—specify them. B. Unnatural sounds, (rales, ronchi)—specify them. States of the respiratory apparatus indicated by these sounds. (For modifications of vocal sounds in diseases of respiratory organs, (see Voice, &c.) Percussion—define.

Physiological relations of the Respiratory movements. Depend directly on the nervous system. (See reflex motion.) Hence increased by stimulants; diminished by Sedatives. Their pre-

cise object as subservient to Aeration. The winds take the place of these movements in plants. The air is *drawn* into the lungs, how? in *reptiles* it is *forced* in—explain. The inspired air passes less and less rapidly as it approaches the air-cells; more and more rapidly as it returns. The air inspired is not expelled by the next expiration. Explain. A quantity always remains in the air cells. How much air inspired (average) at a time? The terminal bronchial tubes (explain) control the passage of the air through them into the air-cells, as the terminal arteries do that of the blood into the capillaries. Analogies in structure as well as function. The Spirometer. What is cough? its final cause in health.

The respiratory movements also indicate our mental emotions; and our corporeal states—Laughing—Sighing—Weeping—Yawning—Sneezing, &c.

Pathological relations of respiratory motions. Some have been alluded to above. Will be too frequent in sthenic diseases; too slow in asthenic. Specify their modifications in diseases of the chest—e. g. Pneumonia, Pleuritis, Bronchitis, Hydrothorax, &c. May be excessive: or diminished tonicity of terminal bronchi; the former relieved by narcotic inhalations, the latter by stimulants. Dyspnoea—Emphysema—Asthma—two kinds. Cough, as a pathological sign.

B. AERATION.

Is performed by the air cells. Their structure—how clustered round the terminal bronchi? How communicate with each other? Their average size. Size compared with the capillaries distributed upon them. How the latter distributed to secure aeration of blood in them from both sides? Computed number or air cells in both lungs. (Rochoux.) Aggregate surface presented by them to their contained air, compared with external surface of body. Distance of air in them from blood in the capillaries. Peculiar position of red corpuscles in pulmonary capillaries. (Wagner.)

Objects of Aeration both indispensable to vital action. (p. 25.)

1st. Removal from the blood of carbonic acid, *(Decarbonization)*, formed:

A. from molecular decomposition (organic waste) and the still more abundant dynamic waste, (in Muscular and Nervous systems). See p. 16, A.

B. from combustion of Calorific elements of our food; and of the portion of the Bile formed from them. (p. 15, 3d.)

Proofs of the elimination of carbonic acid thus assumed. Different composition of venous and arterial blood in this respect. Composition of inspired atmospheric air; do. of the expired air. Proofs of the derivation of this carbonic acid from the sources above mentioned.

The *quantity* of carbonic acid eliminated in any given time varies with the following circumstances;

1st, The temperature of the air—greater in a cold atmosphere.
2d, Muscular action—increased during exercise—least of all during sleep.
3d, State of Digestive function—greater after a full meal.
4th, Size of the body—males eliminate much more than females. But children more proportionally than adults, why?

Illustrate the preceding propositions; specify the reasons.

Table showing the amount of *Carbon* (contained in the Carbonic acid) excreted from the lungs of males and females of different weights and ages, in 24 hours. (Scharling.) Remarks. The average in active adult males not less than 9 oz. (Troy) of Carbon per diem; corresponding to 32½ oz. of *Carbonic acid*, which contains 23½ oz. of *Oxygen*.

The expired air also contains the *Halitus* from the Lungs—its source—its composition—often impregnated with odorous substances, medicinal, or otherwise—illustrate. Causes of a fetid breath.

The 2d *Object* of Aeration is *Oxygenation*: i. e. combination of Oxygen with the Blood. Proofs of this combination from analysis of expired air &c., &c. Amount of Oxygen consumed in 24 hours, varies with the circumstances above-mentioned in respect to the carbonic acid—repeat them. Give the reasons. Why the Oxygen consumed and Carbonic acid excreted always directly proportional?

But Oxygenation and Decarbonization are not necessarily and *immediately* associated as cause and effect; latter may continue for a time if another gas than Oxygen be inspired. Infer; carbonic acid exists *as such* in venous blood, and is *not* formed in the pulmonary capillaries by the *direct* union of the inspired oxygen with carbon.

Still the expired carbonic acid must have been formed from carbon in the blood combined with Oxygen previously inspired. The oxygen appears to be *directly* united with the blood as follows:

1st, With the *red corpuscles*. Unites with their iron, how (Liebig)—with their other constituents (Mulder). Consequent change in their color and form, variously accounted for. (Dr. Rees, &c.) Are thus "carriers of oxygen" (explain), which they give up in the general capillaries to produce the "metamorphosis (decomposition) of the tissues," (molecular and dynamic waste.) Why are they not needed in the white-blooded animals?

2d, With the various elements constituting the liquor sanguinis, probably; to elaborate them more highly. Little known on this subject. Oxygen certainly combines with the *white* blood of the animals just alluded to. It forms tritoxide of Proteine, &c. (Mulder.) With the Hydrogen of the decomposed tis-

sues, it forms water: e. g. in halitus of lungs, &c., &c. But *especially* it unites with the carbon in the blood, from whatever source derived (p. 26, A, B.) and forms carbonic acid, to be excreted in the expired air (Decarbonization).

Experiments with other gases than oxygen indicate that the simultaneous consumption of oxygen and elimination of carbonic acid gas are owing to Endosmosis merely. Specify the experiments alluded to. Law of the mutual diffusion of gases by Endosmosis. Confirmed in the process of Aeration: 1174 parts of Oxygen being replaced by 1000 parts of Carbonic acid gas in the expired air. Other gases than Oxygen cause the Exosmosis of Carbonic acid for a time: why not permanently? Carbonic acid gas itself if inspired, will not admit of this Exosmosis at all, why?

Since but 1000 parts of the 1174 of Oxygen, reappear in the expired 1000 parts of carbonic acid, 174 parts (or 15 per cent.) are consumed in the formation of water, &c., as above, and in *vital* combination with the organic constituents of the blood. The formation of water and of carbonic acid appears to be a mere *chemical* action, here as elsewhere.

The oxygen in the blood not *all* derived from the atmosphere. An additional quantity results from the decomposition of the tissues, and of the Calorific elements of the food. Remarks on its final destination.

Physiological relations of the Aerating process.

A. The objects of *Oxygenation* are:

1st, To produce the decomposition of the tissues (see Oxygen as a vital stimulus, p. 4)—the oxygen being carried into the general capillaries by the red corpuscles.

2d, To combine with, and aid in elaborating the organic elements of the blood. Thus Aeration is the *final* function of Hæmatosis (p. 12); explain.

3d, To combine with the Carbon in the Blood, whencesoever derived (3 sources, p. 26) and convert it into Carbonic acid. N. B. Not *all* the Carbon in the Blood any more than all the Oxygen, is employed to form Carbonic acid. A quantity of both enter into the composition of the secretions, e. g. Bile, &c.

4th, To convert the free Hydrogen in the blood (its source, p. 27) into water. Thus the products of Aeration are carbonic acid and water. Some of the Oxygen also forms Sulphuric and Phosphoric acids, by combining with the Sulphur and Phosphorus of the food and the decomposed tissues.

All the above results are attended by the development of heat; all but the 2d are apparently instances of pure *chemical* action. (See Calorification, p. 30.) But the Dynamic results *accompanying* the first are purely *Vital*. (See Motion and Sensation.)

B. The object of *Decarbonization* is merely to remove from the blood the carbonic acid just accounted for; this being an Excretion. (See Secretion.)

Why must oxygen then be constantly entering the blood? Why the carbonic acid constantly leaving it? Mere non-decarbonization more rapidly fatal than non-oxygenation; proofs. Inference. Effects of carbonic acid gas in inspired air—Do. of deficiency of Oxygen—do. of increase of do. Necessity of ventilation, illustrated. Most common errors in this respect. The aerating process modified by difference of climate—explain. Effects on aerating organs. Inferences. Indications.

Is the Nitrogen in the inspired air affected by the Aerating process?

The following are always directly proportional to each other:

The dynamic activity, dynamic waste, amount of oxygen consumed, quantity of nutriment required, amount of the red corpuscles in the blood, activity of Respiration and the Aerating process, amount of carbonic acid eliminated from the lungs, and the natural temperature of the body. Explain at length. Inferences.

The *skin* also is to some extent, an *aerating* organ—Proofs. Inferences. State of the Aerating process during the Hybernation (explain) of animals. Remarks. Function of the Thymus body. (Dr. Simon.)

Pathological states of the Aerating process:

1st, Total suspension of Aeration, called Asphyxia. Effects of non-decarbonization on the pulmonary capillaries. Explain at length. Why is the right heart full and the left empty after death from Asphyxia? Why a liability to Pneumonia during recovery from it? Its most common forms—Hanging—Drowning—exposure to charcoal fumes (carbonic acid gas)—Indications.

2d, Deficient Aeration (gradual and partial Asphyxia). Effects on pulmonary capillaries. Why produce pulmonary congestion? serous effusions into the air cells? Pneumonia? general lividity (venous congestion)? dilatation of right heart? muscular debility? torpor of intellectual faculties? coldness of the body? &c. Why produce fatty degeneration of the Liver? do. of the Kidneys? Why predispose to Phthisis?

All these effects may result from:

A. Impure air—Indications.

B. Deficient Respiratory movements; e. g. in affections of Medulla Oblongata, or general nervous debility (typhoid, &c., &c.)—Indications.

All gases (or *vapors*) but Oxygen, if inspired produce abnormal effects; inducing 1st, Deficient (or null) Oxygenation, and its consequences, diminished strength, sensibility, consciousness, &c.—and 2d, partial or total non-decarbonization also, (Asphyxia) and

its effects,(e.g. pure hydrogen, carbonic acid gas,&c.) Some vapors also act at the same time directly on the Nervous system as Stimulants or Sedatives. E. g. nitrous oxide gas; &c.

Effects of inhalation of Sulphuric Ether, &c., explained. Here is A. deficient Oxygenation: Proofs—B. an *increased* evolution of Carbonic acid (MM. Ville and Blandin)—C. a Sedative effect on the Nervous system. Why the effects so rapidly induced, and so transient? Why is oxygen the best remedy if Etherization be carried too far? Why do differences in the temperature of the ethereal vapor, vary its effects? Rules for its safe administration to annul pain. (Dr. Snow.)

CALORIFICATION.

Define the term—This Sub-Function common to *all* living bodies; hence its result is properly termed *Organic* (not Animal) Heat.

Table showing the natural temperature of various kinds of vegetables (Paine). Remarks. Their heat is greatest during development of organs of Fructification—also great during germination of seeds. In both these cases, much Oxygen is consumed.

Table showing the natural temperature of the various classes of animals; birds having the highest. Have Arctic animals of the same species the highest temperature? Illustrate.

The natural temperature of the human body—slight varieties in different climates. Table illustrating this (Dr. J. Davy). If suddenly reduced to 79° in healthy adults, death is inevitable.

The evolution of the Organic Heat is apparently a result of the performance of all the Organic Functions; especially *Oxygenation*, (formation of Carbonic acid and water, &c., p. 28) and the conversion of fluids (blood) into solids (*Nutrition*). The first appears a purely *chemical* source of heat; the 2d a *vital* one, and not the mere extrication of latent caloric.

The increase of heat sometimes occurring after death indicates a *chemical* cause; at least not a *vital*. Organic heat does not depend on the nervous system (certainly not in plants); but is modified by it just so far as it *primarily* modifies the organic functions. Calorification has been said to be itself the last function to fail; how explain this apparent fact. The Organic heat has been classed with the secretions (Paine).

Organic heat varies then with amount of oxygen consumed; and the other proportionals on page 29th—why? Hence varies with time of day (Chossat), season of the year (Edwards), and other circumstances under Oxygenation (p. 27). Explain. Calorific power is feeble in infants; and in old age, why? How the great heat developed by insects (white-blooded) accounted for, they having no "carriers of oxygen?" All very young animals have feeble Calorific powers: the more so the more helpless at birth. Average temperature of new-born infants (Roger). The calorific powers of animals in the state of Hybernation. Refer to

the Calorific Elements of the Food (p. 17). Does animal diet excite organic heat more rapidly than vegetable (Paine)?

Physiological relations of the Calorific process. Importance of the Organic Heat (see Heat as a Vital stimulus, p. 4). Is also a *sensation* of Heat not connected with this, depending on a morbid state of the sensory nerves—Mere *sensory* heat does not affect the thermometer; organic heat does.

Most animals confined naturally to particular climates, why? Man maintains nearly a uniform temperature, whether in a climate with a temperature of 130° (India) or —70° (Arctic regions). Can also withstand a much higher *artificial* temperature. Experiments of Blagden, Chabert and others. A *frigorific* process is established to neutralize the heat in such cases; explain—the heat of the body being increased not more than about 6°. How many degrees depressed by extreme cold, short of fatal effects? *Proximate* cause of death from exposure to cold. Extreme tolerance of cold in the Zincali (Borrow).

The *skin* also is a calorific organ—experiments of Becquerel and Breschet. More dryness of the skin increases the apparent organic heat—explain, (fevers, &c.)

Physiological objects of Dress. Common errors in this respect.

Pathological states of the Calorific process. Much of the heat felt in some diseases is merely *sensory*. Organic heat is *increased* in Fevers (103° to 113° in typhoid, Piorry); how explained by Dr. Christison—in Inflammations—in Pneumonia blood was 113° (Piorry)—Phthisis, (114°. Do.)—Scarlatina, (106°, Dunglinson)—Tetanus, (110°, Prevost.) In the uterine system is sometimes 120° (Granville)—Hot stage of intermittent (109°, Craigie)—Injuries of spinal cord, or spinal nerves. Accession of facial Neuralgia. Explain.

The organic heat is *diminished* in cold stage of intermittents (to 74°, Dr. Phillip)—in debilitated states of the nervous system, implicating the respiratory movements, or indirectly affecting the organic functions (specify)—Affections of the Brain—Paralyzed limbs (70°, Earle)—Injuries of great sympathetic (78°.8, Chaussat)—Apoplexy—temperature rises after death, very uniformly (Dr. Cheyne). Asiatic Cholera (78°)—Icterus (96°.40)—Diabetes (Do). Organic Heat diminished in Etherization (Blandin). The ordinary range of temperature in disease in adults is 95° to 107° (Andral)—in infants 74°.3 to 108°.5. (Roger.)

Chilliness experienced by patients is often mere *sensory* cold.

The *proximate* cause of death from starvation is non-calorification, (Chossat.) Infer the importance of external heat, and of stimuli (calorific elements, though the stimulants *also* excite the respiratory movements directly) in extreme inanition, &c. (p. 17.)

Death from starvation occurs in birds when 40 per cent. of their weight has been lost (Chossat). Most of this burned as fuel; explain.

Remarks on the correlations of the preceding Functions of Hæmatosis—Effects of Bloodletting on the function of Absorption—on action of Heart and Arteries—on Respiration—and Aeration.

Have disposed of the 1st object of Sanguimotion (Aeration, p. 22); now follows the 2d (Nutrition and Secretion). Have seen how Blood is *formed;* next how is it disposed of.

SUBDIVISION II.

NUTRITION PROPER, AND SECRETION.

Secretion implying *Separation* of certain elements from the Blood, the 1st stage of the Nutritive process may be included under that designation. The 2d cannot. (See below.)

But the proper secreting function of the glands depends on their peculiarities in respect to Nutrition. In this view Nutrition includes Secretion. (See Secretion, p. 36.)

V. FUNCTION OF NUTRITION (AND ASSIMILATION).

Nutrition is the Function which forms the tissues from the Plasma (define); whether we consider:

1st, Their *original* formation from cells, (Development, p. 11).

2d, Their *increase* in amount, (Growth).

3d, Their apparently *permanent* condition in the healthy adult, (Balance of repair with the dynamic and organic waste).

Are two stages of the Nutritive process:

1st, Separation (Secretion) of the required elements in the Plasma, (Exudation (p. 24) of Plasma; *Plasmexhidrosis*).

2d, Conversion of the exuded Plasma into the several tissues, (*Organization* of Plasma). Each tissue has the power of appropriating the required elements of the Plasma to *itself* and thus repairing its loss, (Assimilation).

Both of the above are *vital* processes. Proofs. Influenced by Nervous system; not dependent on it. Proofs.

The organs and parts concerned in the Nutritive process are the general Capillaries and the inter-capillary spaces, (Explain). *Organization* occurs in the latter. (For mere *Sanguimotory* function of the capillaries, see p. 24th, 3d.)

Specify the phenomena of waste and repair:

1st, How are the existing tissues destroyed (p. 27)? The ele-

ments resulting from their decomposition, how disposed of? (See difference in Arterial and Venous blood, p. 23, and sources of Lymph, p. 18, B.) How these elements eliminated from the Blood; except the Nitrogen? (See Aeration.) How the Nitrogen do? (See Secretion.)

2d, The waste is repaired by

A. *Plasmexhidrosis.* Does not imply rupture of Capillaries; Extravasation does—explain. What if the Exudation be slightly excessive? (Sources of Lymph, p. 18, B.)

B. *Organization* of Plasma. Explain at length.

The Liquor Sanguinis alone affords the Plasma; proofs—the red Corpuscles produce the waste (p. 27). Hence Oxygen and Nutriment (waste and repair) should be proportional (see also p. 29. B).

Physiological considerations. The vast importance of this Function. The rapidity of waste and repair vary at different ages—explain. Activity of nutrition varies in particular organs at different periods of life; e. g. Liver, Thymus body, &c., in the Fœtus. Particular parts and organs remain undeveloped till a particular period of life; explain. Constitutional peculiarities in the Nutritive Function. How long (average) is the whole adult human body in being removed and recomposed, by waste and Nutrition?

Each tissue and organ selects not only its appropriate materials from the blood; but also particular non-nutritive (e. g. medicinal) substances contained in it. This a fundamental principle in Therapeutics. E. g. Local effects of Lead—Arsenic—Iodide of Potassium—Balsam Copaiba. Even peculiar morbid states of blood itself affect particular parts; illustrated by symmetry of cutaneous diseases, &c.—explain.

The activity of the nutritive process varies with,

1st, Activity of circulation of the part, within healthy limits.

2d, Exercise of part. Illustrate these two propositions. Reasons.

The *Reparative Process* (explain) is merely a modification of the Nutritive, adapted to the requirements of the part. How differ from common Nutrition? Has no necessary connexion with Inflammation; is even opposed to it in its results. Proofs. Here the Exudation is *plastic;* in Inflammation, *caco-plastic.* Explain.

Modifications of the Reparative Process (Dr. McCartney).

A. *Adhesive Process.* Explain at length.

B. *Modelling Process.* do. do.

C. The true *Suppurating Process,* (Union by Granulation)—The last follows Inflammation; the others not. (For characters of true Pus see works on Pathology.)

Pathological states of the Nutritive Process.

A. Disturbed Equilibrium of waste and repair.

I. *Diminished* Nutrition *(Atrophy)*.

1st, From cessation of repair (waste continuing): no nutriment being consumed, e. g. Fevers (there being Anorexia) —Starvation; here emaciation is very rapid. Birds lose $\frac{1}{10}$ of their weight before they die thus (Chossat).

2d, From inadequate repair, though food is taken: it not being converted into Plasma, e. g. in Phthisis; Tabes Mesenterica, &c., or any disease implicating either of the Functions of Haematosis. Bad diet (or in too small quantity) alone may lead to this result.

3d, From increased waste, the ordinary repair continuing; e. g. in case of any *drain* on the system—Lactation; Diabetes; Suppuration: excessive exhaustion of Nervous system, &c.

Individual peculiarities under this head.

Local atrophy may result merely from diminished circulation through the part; hence often results from pressure, disuse of part, (e. g. paralyzed limb) &c. Illustrate. The *Ulcerative process* is allied to local atrophy. Explain. It has no *necessary* relation to Inflammation; nor to Ulcers—Explain.

II. *Increased* Nutrition *(Hypertrophy)*. General Hypertrophy, and that of the muscular system merely, not a morbid state; while general atrophy is so. Causes of the former. Individual peculiarities in this respect. General H. cannot be produced at will beyond a certain extent in each individual; *Plethora* alone results from an excess of food in such cases. *Local* Hypertrophy of most internal organs is a *morbid* state; e. g. of Heart, Bladder, Liver, Brain, &c. But may still produce salutary effects in the circumstances: e. g. *final cause* of Hypertrophy of Heart, and of Bladder, generally. Important then to know the normal size and weight of each organ. External Hypertrophy may be removed by pressure, (e. g. of mamma,) why?

B. Abnormal state of 1st stage of Nutrition *(of Plasmorhidrosis)*. Is *excessive* in *Inflammation; no* Plasma being needed in the state of the part. Signs of this excessive Exudation in an external part; Pain, Heat, Redness, and Œdema. But these are not distinctive of Inflammation. Proofs, &c.

Specify all the other elements of Inflammation in connexion; both local and general—and its essential and accidental characteristics.

Inflammation is always a *morbid* process. Contrast it with the *Reparative* which is never so.

How is the excessive Inflammatory Exudation disposed of?

1st, Is absorbed by Lymphatics of the part (Inflammation ends in "Resolution.")

2d, Produces death of the part, (do. ends in Mortification.)

3d, Is decomposed, (Softening) and must be removed by Ulceration, &c. Afterwards the injury is repaired by the Granulating process.

4th, Becomes *imperfectly* organized (Induration, False membranes, &c.); the exudation being always *caco-plastic*.

C. Abnormal state of 2d stage of Nutrition *(Organization)*.

1st. *Tuberculosis* (including Schrophulosis). Exuded plasma is Caco-plastic, and Tubercles instead of the proper tissues are formed. Characters of tubercle. Produce no morbid effects (unless it be mechanically from their mass) while retaining their vitality *(crude* tubercles); on losing it they soften, and finally produce ulceration, now being "foreign bodies" (explain). Peculiarities of the Plasma leading to the formation of Tubercles. This may result from 1st, Food deficient in quality or quantity. 2d, Deficient activity of functions of Hæmatosis. Explain. Why tuberculosis often retarded by Pregnancy?

2d, *Abnormal growths.*

A. *Non-malignant*—tumors, &c., of various tissues. Classify them.

B. *Malignant Growths*—their peculiarities. Classify them.

Why children peculiarly liable to Inflammatory diseases? and to Tuberculosis? Indications. Why their diseases so rapid in their progress?

Effects of Bloodletting on the Function of Nutrition—on its modifications, especially Inflammation.

Have seen how the Blood is converted into the *Solids*. Next, how are the various *Fluids* formed from it?

VI. FUNCTION OF SECRETION.

This, as a distinct Function, separates from the Blood all the Fluids of the body, except Lymph and Chyle (p. 11, B). How distinguished then from 1st stage of Nutrition (p. 32).

The secreting *structure* essentially the same in all cases; *cells* alone actually secreting (p. 5, A). But secreting *organs*, assume various forms; glands, crypts, follicles, &c., define. Hence same gland varies much in different animals; while its secreted fluid is very similar in all. Illustrate.

The secreting power of each individual cell producing the pure *Secretions* (see below) is identical with its Nutrition; and is a purely vital function. Those producing the *Excretions* apparently possess *also* a physical or chemical force (p. 4, A, B). Explain at length. Secretion modified by, but not dependent on, the Nervous System. Proofs.

Secretion is then the result of the peculiar Nutrition of the secret-

ing surface. Every free surface of a vascular structure must secrete, why?

Secretion is arrested by the *opposite* states of Congestion and Hypæmia (explain) of the secreting organ. Illustrate. Hence all the secretions changed in Anæmia, &c.

The *objects* of Secretion are:

A. To separate from the Blood, fluids containing elements deleterious to the Organism (the *Excretions*).

B. To separate fluids destined to perform important offices in the body (the *Secretions*).

Difference between Secretion and *a* Secretion—Double meaning of the term Excretion; as a sub-function, it denotes the *dynamic* actions necessary to remove *an* Excretion from the body, e. g. Defecation, Micturition, &c.

The Excretions cannot long be retained in the body without injury, why? the Secretions are always retained, and finally reabsorbed—explain. Non-secretion (retention in the Blood) of the former, produces *general* disorder; do. of the Secretions, merely *local* do.; why? Attention to the Excretions of the highest Therapeutical importance. The Secretions are fluid in all animals; why? the Excretions vary in form to suit the requirements of the case; e. g. solid urine of serpents and some sea-birds; and carbonic acid gas from the aerating organs of all animals.

Table showing by what organs the 15 elements in the body (p. 6, A) are *directly* separated from the Blood. They are all *finally* removed from the body by the five emunctories; the Lungs, Skin, Urinary passages, Liver, and Alimentary canal; the last removing the Hepatic Excretion, and the intestinal Mucus, in the Fæces.

A. THE EXCRETIONS.

How distinguished from the Secretions? Are normally produced only on mucous surfaces and the skin; explain. In disease they may be formed on other surfaces; e. g. pus in cavities, or on a granulating surface, &c, Every free vascular surface becomes an aerating organ if exposed to the air; proofs—and thus produces an Excretion.

The principal deleterious *elements* eliminated in the Excretions are the Carbon, Hydrogen and Nitrogen of the decomposed tissues. The Excretions themselves are Bile, the cutaneous Perspiration, Carbonic acid, Urine, and intestinal Mucus. *Carbon* and its compounds enter largely into the first three; *nitrogen* into the Urine. The Fæces are an Excretion only so far as they contain Bile and Mucus; the residual matters in them never having entered the blood.

Of these, three are Excretions merely; viz. Urine, Perspiration, and Carbonic acid—all having an acid reaction. Two are both Excretions, and Secretions (explain), i. e. *mixed* Excretions, viz.

Bile, and intestinal Mucus—both having an alkaline reaction (Simon). But *buccal* Mucus is acid (p. 13, B); gastric fluid (see p. 16, top) is uniformly so.

All the true *Secretions*, (if Gastric fluid is classed with the *mixed* excretions,) have an alkaline reaction.

I. *Carbonic acid gas;* secreted by the Lungs, Skin, and any internal membrane brought into contact with the air; e. g. that lining bones of birds, &c. Refer to the subject of Aeration, p. 26 to 30.

II. *Intestinal Mucus*—its properties, and its uses as a *Secretion* (see Digestion, p. 15, 5th). All mucus but that of the alimentary canal appears to be a Secretion merely, and like other Secretions is Alkaline. The *fluid* portion of mucus (microscopically examined) is *always* alkaline (Simon). Inference.

For the objects, as a Secretion, of the Gastric fluid, see p. 14. Its excrementitious elements, like those of the intestinal mucus, are doubtless of small amount, and are excreted in the Fæces.

III. *The Bile.* Its chemical composition, according to Berzelius —Thenard—Demarcay and others. Formula of its principal organic element, Bilic acid (Bilin, Picromel, Cholcic acid)—do. of Cholesterine. These abound in Hydrogen and Carbon. Biliphaein, Biliverdin, and Bilifulvin.

Morphology of the Biliary Apparatus in the animal series.

Structure of the human Liver, according to Kiernan. Its great size in the fœtus, how accounted for?

Uses of the Bile (p. 15). The *Alkaline* elements are reabsorbed as a mere Secretion, after converting the Chyme into Chyle. The *Calorific* are likewise carried with the Chyle into the Blood, though previously separated from it as an excretion. In the Blood these elements (principally of Carbon and Hydrogen) are converted by the Aerating process into Carbonic acid and Water (p. 28, 3d, 4th); the Organic Heat is thus, in part, maintained (do. 4th); and finally these compounds are *excreted* by the Lungs, Skin, &c. (p. 29, B.)

The *Resinous* portion of the Bile *alone* is *not* re-absorbed; acting as a stimulus to the dynamic powers of the alimentary canal, and then being excreted in the fæces. It forms about $\frac{1}{27}$ of the Bile (Thenard), and is associated with the Biliphaein.

Physiological relations of the Bile. The Calorific Elements which enter the *Mesenteric veins* from the Alimentary canal, (e. g. *saccharine matters*, &c.) are carried by the Vena Portæ to the Liver, and the Bile secreted; when the blood thus purified passes on to the right heart. The Hydro-carbon of the Bilic acid, &c., is subsequently "burnt" by the Aerating process. Results (p. 28). But the *fatty* Calorific Elements, being carried through the *Lacteals*, &c., to the right heart, are consumed as above, with-

out having traversed the Liver (Carpenter). Distinguish then between Calorific elements of the *food* and those of the *Bile*.

Thus the Liver is associated with the Lungs and Skin as an eliminator of Carbon. The reciprocal relations of the three. How varied by changes of climate? Explain at length. Liver and Lungs in inverse ratio, in respect to size, in the various animals; why? (e. g. liver large in reptiles, small in birds, &c.)

The Liver the only eliminator of Carbon in the body of the Fœtus. Why none other needed? Why *this* required? Sources, composition, and uses, of the Meconium.

For relations of Bile to Digestion, &c., see p. 15.

Pathological relations of the Bile (see also p. 15). Effects of its non-secretion on the organism generally. Do. do. on the pulse—and on Nervous system. Account for these effects. Is non-secretion more deleterious than reabsorption of the Bile (e. g. from obstruction of gall-duct)? Why? General indications in both cases.

All the Bile is discharged in the Fæces in certain morbid states—specify. Precise change of structure called "fatty degeneration" of the Liver (Bowman). Why Phthisis often produce it? Why gradual Asphyxia produce excess of Bile? Why excess of Calorific elements in the food in warm climates produce Hepatic disease? Why deficient action of Liver lead to portal congestion; and Ascites?

Morbid changes in composition of Bile (see p. 15).

IV. CUTANEOUS PERSPIRATION (SWEAT).

Is constantly secreted—Sensible and insensible, define. Its specific gravity (Simon). Its chemical composition (Anselmino). Its solids amount to from 1½ to 2 per cent; chloride of Sodium being the most abundant. What other salts? Has an acid reaction, owing to free acetic, and lactic acids. Its odor is peculiar in different tribes of men, and different individuals; and in the two sexes. But the odor proceeds from the *sebaceous secretion* which must be distinguished from the Perspiration.

Structure of the Skin; especially of the Perspiratory Apparatus (Glands and Pores). Aggregate length of latter in human body, 28 miles (E. Wilson). They are not found in the skin of the Dog?

Amount of insensible Perspiration *(average)* per diem is 29 oz; do. exhalation (Halitus) from Lungs (water nearly pure), 18½ oz. (Seguin.) The *solids* in the former amount to about 2½ ounces; the remainder is mostly water acidulated as above.

But much of the water given off from the Skin, is a mere Exhalation (Evaporation) and is not secreted by the Perspiratory glands. This a mere *physical* phenomenon, occurring in some degree at the lowest temperature, and even after death (Edwards). (So is the Exhalation from the Lungs.) The maximum is exhaled during digestion; the minimum during meals. Increased by a warm,

dry, light atmosphere. It thus becomes the *Frigorific* process (p. 31.) Is diminished by a moist, dense, calm atmosphere. Hence varies with season of year, &c., &c. Is greatly increased in certain debilitated states of the system; e. g. after hemorrhage, and in colliquative sweats. How explain these? Indications. No peculiar exhalent *vessels* exist.

The skin also gives off Carbonic acid, and Nitrogen gases (Collard de Martigny); the former, as an Aerating organ (p. 29, B). The skin is more efficient in this respect than the lungs, in the frog. (Edwards.) The quantity of Nitrogen exhaled from the Skin, in man, is about 100 grains daily (Carpenter).

Physiological relations of the Skin.

1st, Is associated with the Liver and Lungs, as an emunctory of Carbon.

2d, Do. with the Kidneys, as an eliminator of Nitrogen.

3d, With the Lungs and Kidneys to remove water from the Blood. There is also a reciprocal relation between its exhalent action and that of alimentary canal; e. g. diarrhœa produced by a chill, &c.

The antagonism of the exhalations from Skin, Lungs, Alimentary canal, and Kidneys—explain. Therapeutic inferences.

Importance of maintaining the healthy action of the skin. Means of securing this result. Naturally more active in the female than in males equally sedentary?

The Perspiratory *secretion* affected by the Nervous system; e. g. in *opposite* ways by mental emotions. How explained? The *exhalation* also thus affected; how explained; but far more by *physical* causes. Diaphoretics; some principally increase the *secretion*—others the *exhalation*. Specify. In what diseases indicated. Severe physical pain often a Diaphoretic, why? Why is exercise so? Warm water? &c.

Pathological relations of the Skin. Total inaction of it produces death (Fourcault) in lower animals. Diminished do. produces diseases of Lungs—of Liver—and of Kidneys (Albuminuria). Latter sometimes a sequel of Scarlatina, why? So is Ascites, or Anasarca, why? Infer; maintain a due action of the skin in diseases of all these organs. The febrile symptoms in the Exanthemata an *effect*, merely; explain. Do. in part, in Burns and Scalds. The *Dryness* of skin in idiopathic fevers, how accounted for (p. 36, top)? Importance of daily ablutions in all febrile diseases. Excessive perspiration after cold stage of intermittents; how explained. How "critical sweats." The exploded idea of "peccant humors" thus discharged. What is a "cold." What the state vulgarly called, being "melted?" Indications.

Abnormal states of the Perspiration in Diseases (Simon).

1st, Change of *odor*. In Scabies is a mouldy odor—sweet in Syphilis—acid in Rheumatism and Gout; like musk, in Jaundice:

like sour beer, in Scrofula; like fresh brown bread, in intermittents. But these distinctions depend very much on the observer.

2d, Change in *composition*. Excess of *Acetic acid*, in Hectic (Prout), acute Rheumatism, and confinement after parturition. Excess of *Lactic acid*, in acute Rheumatism, Gout, Scrofula, Rachitis, and some Cutaneous eruptions.

Is excess of *Ammonia* after attacks of Gout (Anselmino); in putrid and typhus fever (Berend). All putrid sweat probably contains free Ammonia.

The *Chloride of Sodium* was increased in a case of Dropsy (Prout); the *Phosphate of Lime* in gouty and urinary concretions.

The sweat is *Alkaline* in certain nervous diseases.

3d, *Abnormal constituents* of Sweat. *Albumen*, in a critical sweat in a case of acute Rheumatism (Anselmino); in gastric, putrid, and hectic diseases, and in patients moribund (Stark). *Blood*, in scurvy, putrid fever, and typhus icterodes. *Uric acid*, in gout (Stark); in a case of vesical calculus (Wolff). *Urate of Soda*, in gout, and stone. *Biliverdin*, and Bilin, in Jaundice, &c. *Uro-erythrin*, in a fever patient (Landerer). *Blue perspiration*, in abdominal disease (Dr. Bleifuss); in hysteria and hypochondria (Michel). Fat, in colliquative hectic sweats. Much of the preceding needs confirmation.

4th, *Foreign substances* in the Sweat; especially *medicinal*. The following have been detected in it. Quinine, Sulphur, Mercury, Iodine, Iodide of Potassium, Asafœtida, Garlic, Saffron, Olive oil, Rhubarb, Indigo, Prussian blue, and Copper.

V. URINE.

Consists of water holding certain solids in solution. These vary from 36 to 67 parts in 1000, according to amount of fluids (water) taken; and much more in disease. Is almost entirely solid in some animals (p. 42).

Morphology of the Urinary Apparatus throughout the animal series.

Structure of human Kidney, and other parts of Urinary Apparatus. Surrenal capsules in the Fœtus—their probable uses.

Specific gravity of Urine (average)—varies with relative amount of solids in it; hence what circumstances increase it? and diminish it? The Urometer.

Average quantity of Urine per diem, 45 oz. (Simon); the fluctuations being greater however than of any other excretion. Variations according to age; season; state of skin, &c. Average is however very nearly the same in the same person.

Is a very complex fluid, containing 19 or more constituents besides water. Its chemical analysis, by Berzelius—Lehmann—Becquerel, &c. Its acid reaction owing to its free lactic and carbonic acid. Here follows Simon's Analysis.

Water,				963.20
Urea,	12.46	Organic compounds.	12.98	Solid Residue. 36.80
Uric acid,	0.52			
Lactic acid, and Alcohol extract,	5.10	Extractive; and Ammonia salts.	10.14	
Spirit Extract,	2.60			
Water Extract, & Vesical Mucus,	1.00			
Lactate of Ammonia,	1.03			
Chloride of Ammonium,	0.41			
" Sodium,	5.20	Fixed Salts.	11.19	
Sulphate of Potassa,	3.00			
Phosphate of Soda,	2.41			
" Lime and Magnesia,	0.58			
Silicic acid,	a trace			

Berzelius and Marchand find also Sulphate of Soda about 3.18, and Biphosphate of Ammonia 1.6. Liebig denies the existence of Lactic acid. Traces of peroxide of iron, and fluoride of Calcium are found in urine. Also carbonic acid gas in solution (Simon.)

Of the *solids* (the only *peculiar* part of the Urine) about $\frac{1}{3}$ is composed of fixed and Ammoniacal salts; and the remainder of Organic compounds, principally the *Secondary* (p. 10).

A. The *Salts; (Fixed and Ammoniacal)*—the most abundant (see table); are more of the alkaline and earthy phosphates, than in the blood. Some salts precipitated on mere cooling of the Urine; others require its evaporation. Urinary "deposits;" define. Two kinds, Saline and Organic. The phosphates held in solution by the acids of the Urine; hence alkaline state of it produces phosphatic deposits, the most common of the *saline*. Peculiarities and tests of these deposits.

The salts are *derived* from the decomposed tissues, and the elements of the food; (especially the unassimilated)? They appear to enter the uriniferous tubes with the *water*, as a mere Exhalation (p. 38). The Sulphates and Phosphates result from the waste of Nervous system; hence increased by violent exercise; especially the former (Simon)—and the latter by mental exertion. Illustrate. The Chloride of Sodium varies, with the *food*, from 29 to 116 grains per diem.

The *bases* of the Sulphates and Phosphates enter the stomach in combination with vegetable acids, e. g. citrate, tartrate, &c. These are decomposed (how?) and Sulphuric and Phosphoric acids replace them. How these two acids formed? Thus the Kidneys eliminate much of the Oxygen of the decomposed tissues, &c. (p. 28.) Explain the action of the above vegetable acids as "Refrigerants."

B. *Organic Compounds.* (see p. 10.) These are totally unorganizable; and most assume a crystalline form after the Urine is excreted. They abound in Nitrogen. The most important is

I. *Urea*—varies from 12 to 50 parts in 1000; average 32 (Dr. G. Bird)—being from $\frac{1}{2}$ to $\frac{1}{3}$ of all the solid residue. Is the simplest of all organic compounds. Its formula. Contains more than twice as much Nitrogen as Proteine, with less than $\frac{1}{3}$ as much Carbon. Form of its crystals.

Urea is derived from, 1st, the decomposed tissues—principally the Gelatinous? (Dr. Prout.) 2d, azotized diet; principally the unassimilated portions?

Urea may be increased *absolutely* by violent exercise (to 45 parts in 1000) why? and by purely animal food (to 52 parts) why? If diet is exclusively vegetable, may fall to 10 or 12. The *average* absolute amount excreted by males daily is 432 grains—do. by females 294 grains (Lecanu). Children proportionally more; very aged persons less—why.

The Urea is *relatively* increased, as are *all* the solids, when but little water exists in the Urine, and *vice versa*—the specific gravity, in former cases, being high. If the latter condition obtains, and the *quantity* be normal, there must also be an *absolute* increase of the solids; though the Urea alone may, or may not, be increased. Tests of Urea, microscopic, and chemical.

II. *Uric* (formerly Lithic) *Acid*—average 1 part in 1000 of Urine (Bird); and little more than 1$\frac{1}{2}$ per cent. of all the solid residue. Liable to great increase in disease.

Is kept in solution by the Soda in the Urine (for 10,000 times its weight of *water* is necessary to dissolve it). Hence any other acid combining with the Soda (even *Carbonic*) precipitates it, e. g. in Pneumonia, &c. Indications. So does a diminution of the Soda—Indications. Form of its crystals. Uric acid and its salts forms the most abundant *organic* urinary deposits. It forms vesical calculi also. Its tests, chemical and microscopic. With Ammonia, forms the almost solid Urine of serpents and carnivorous sea-birds, to the entire exclusion of Urea. In carnivorous Mammalia we find Urea, but no Uric acid nor Urates.

Formula of Uric acid. Contains much more Carbon and Oxygen than Urea, and also much Nitrogen. Is derived, probably, like Urea, from the decomposed tissues (the albuminous, Prout,) and the azotized elements of the food. But is not increased by exercise and animal food proportionally with the Urea. Has no constant ratio in quantity to the latter. Urea derived from Uric acid by oxydation of the latter (Leibig)—objections to this view. This subject needs farther investigation.

Average quantity of Uric acid excreted per diem by males 13.09 grains, or 1 to 32 of Urea (Bird)—Do. do. in females 10.01 grains; or 1 to 29. In disease the quantity varies more than that of the Urea.

III. *Hippuric acid* is a constituent of Urine (Liebig) in small quantity. Replaces the Uric in the Herbivora. Benzoic acid converts the insoluble Urates into the soluble Hippurates; hence of great value in preventing Uric acid deposits; have also *removed* gouty concretions, i. e. Urate of Soda (Dr. Ure). Effects of Phosphate of Ammonia in latter class of cases, explained.

Hippuric acid is soluble in 400 times its weight of water—its formula. Richest of all organic compounds in carbon, except Bile. Its probable source (Dr. Bird). Is increased in torpidity of the Liver?

Of the *other* Organic constituents, *Lactic acid* forms about 1.5 parts to 1000 (Lehman and Marchand). Liebig endeavors to prove that another *anonymous* organic compound has been mistaken for it; while free Lactic acid does not exist in the Urine.

The *epithelium scales*, and the *mucus* in Urine proceed from the urinary *passages*—explain.

Are two *coloring matters* in the Urine, 1st, A yellow tint, *Hæmaphæin* (Simon) identical with the coloring matter of blood-serum. 2d, A rose, red, or even purple, tinge, *Purpurine* (Uro-erethrin, Simon).

The elimination of the preceding organic compounds, is a *vital* action (secretion); that of the salts and water, apparently not so. Still the quantity of the latter is *indirectly* affected by vital force; it is even by the nervous system—explain.

Extractive matters; very little known respecting them. Form about 10 parts in 1000 of Urine (Lehmann and Marchand). Reduced to 5 parts by a purely animal diet; increased to 16½, by a purely vegetable do.

Physiological relations of the Kidneys—of great importance. Are associated with the Skin and Lungs as eliminators of excess of water from the Blood—with the former moreover, as emunctories of Nitrogen and certain salts; with the Skin, Lungs and Liver, in excreting Carbon—explain. They also eliminate much Oxygen. Hence the complicated antagonism of these organs—explain.

Great changes in the Urine from diet. Specify. Purely vegetable diet may render it alkaline.

The Sulphates always increase and diminish simultaneously with the Urea (Simon). How explain this fact?

In regard to specific gravity, must distinguish the Urina potus, U. cibi, and U. sanguinis (explain)—last only can be relied on.

Pathological relations of the Urinary excretion. Of vast interest and importance. Effects of total non-secretion of the Urine—of diminished secretion—Indications. Retention and re-absorption less deleterious than non-secretion.

For the whole subject of Urinary Deposits, their Pathology and Treatment, consult Dr. Golding Bird's valuable work.

Brief directions to be followed in Uroscopy.

Urine becomes alkaline in diseases of Bladder, accompanied by excessive secretion of mucus, why? Hence Phosphatic deposits ensue. Indications.

General indications in diseases of the Kidneys—Nephritis and Albuminuria, &c.

Morbid changes in *composition* of the Urine, may be classed as follows:

1st, Excess or diminution of one or more of the normal constituents of the Urine.

2d, Absence of a normal constituent.

3d, Presence of abnormal substances, e. g. Albumen, Blood, Chyle. Fat, (with or without Caseine,) Biliphacin, Bilin, Sugar, Carbonate and Oxalate of Lime, Pus, &c.

For the particulars under these heads, and the precise composition of the Urine in different diseases, see Simon's Chemistry of Man. (Art. Urine.)

All unassimilable substances entering the Blood, are removed by the Kidneys, in their original, or in a modified condition. For a list (by Dr. Day) of the various substances that have thus been detected as abnormal constituents of the Urine, see Simon as above, p. 550, &c.

Diuretics—remarks upon, at length. Uncertainty of their operation in certain diseased conditions.

Thus, while the Functions of Hæmatosis (p. 28, A. 2d) *make* pure Blood, that of Secretion *keeps* it so, by eliminating the Excretions.

B. THE SECRETIONS.

Repeat their characteristics (p. 36, and 37). Many of them of less practical importance than the Excretions, and will be briefly considered.

The following order and classification (slightly varied from Dr. M. Paine) will be adopted.

I. Serous Fluids. { On Serous membranes; including Synovia. / Of Areolar tissue. / Of the fœtal membranes. / The Aqueous humor; Liquor Cotunnii, &c.

II. Lachrymal Fluid.

III. Digestive Fluids. { Saliva. / Pancreatic Fluid. / Gastric do. (and Bile.)

IV. Mucous Fluids. { On the various mucous membranes.

- V. Fatty Fluids.
  - Fat of Adipose tissue.
  - Marrow of Bones.
  - Sebaceous fluid of Skin and Glans Penis.
  - Fluid of Meibomian Glands; and Cerumen of the ear.
- VI. Fluids secreted by the Sexual Organs.
  - A. Of the Male.
    - Semen; and fluid of Vesiculae seminales.
    - Fluid of Prostate; and do. of Cowper's glands.
  - B. Of the Female.
    - Catamenial fluid.
    - Germinal do. (i. e. of Ovum.)
    - Liquor Amnii, (see I.)
    - Milk.

I. SEROUS FLUIDS.

The simplest of all the secretions—have the lowest specific gravity—resemble the Blood serum, physically and chemically; but are not identical with it, nor all of same composition. Consist principally of water holding Albumen and salts (Chloride of Sodium the most abundant) in solution.

Are never exposed to the atmosphere. Found on all surfaces moving upon each other, however small, even in the meshes of the Areolar tissue. Their object always (except C and D of this class) and almost solely, to diminish friction. Are probably rapidly secreted, and re-absorbed equally so.

A. *Fluids of proper Serous membranes*—Structure of latter (p. 11, B. 2)—specify them. Normal quantity of fluid on a serous membrane. Chemical composition of that secreted by the Peritoneum (Heller).

Synovia—its peculiarities. Chemical composition. Its uses.

B. *Fluid of Areolar tissue.* Structure of Areolar tissue (p. 11, B). Composition of this fluid (Heller). Fills the areolæ of this tissue. Its uses.

C. *Liquor Amnii.* Its specific gravity. Average quantity at term. Chemical composition, (Mack, and Colberg). Its physiological relations.

The *Vernix Caseosa*—its analysis (Dr. Davy). Its origin.

D. *The Aqueous Humor* of the Eye. By what secreted? its amount. Chemical analysis (Berzelius). Uses of this fluid, in Vision. If lost by a wound, is very soon restored—explain. The *Vitreous humor* contains a little more Albumen (1.6 in 1000) and common salt, than the Aqueous. The *Crystalline Lens* abounds in Albumen (244 in 1000) and Crystallin, a kind of Caseine (Simon), (122 in 1000); with a little fat, and common salt. Uses of these structures in vision.

The *Liquor Cotunnii*, and *Liquor Scarpæ* of the Labyrinth of the Ear, have never been analyzed? Their uses.

Physiological relations of Serous secretions. Some of them are secreted after death, i. e. after *somatic* death; the secreting *cells* still retaining their vital powers for a short time. But may not this be a mere post mortem *Effusion?* Re-absorption ceases at death before secretion, why? sometimes even ceases before death; illustrate.

Effects of diminished secretion of these fluids. Increased *quantity* in any serous cavity, may depend on increased secretion or diminished re-absorption—explain.

Pathological relations, &c. Abnormal accumulations of these fluids constitute Dropsies; e. g. (Class A) Ascites, Hydrocele, Hydrothorax, Hydropericardium, Hydrocephalus, Hydrorachis, Hydrops Articuli, &c.—(B) Oedema, Anasarca.

These accumulations may result:

A. From *excessive Secretion;* from irritation of the secreting membrane, produced by tubercles, Ovarian tumors, or previous disease, e. g. Inflammation, &c. Sometimes a serous membrane seems to perform a *vicarious* action (explain) with an emunctory when rendered inactive by disease; e. g. Ascites in Granular degeneration of the Kidneys, &c. Here the peculiar excretion of the Kidneys (Urea) is found in the serous fluid. Other cases of this kind.

Serous *Effusions* (p. 24, 3) may result from mere relaxation of the tissues; also from venous congestion (p. 38, l. 24). They may also be dependent on a peculiar composition of the Blood. Explain.

B. From *diminished Re-absorption.* This probably always follows the previous condition, why? or may alone produce the effect. Any interruption of the circulation, e. g. from debility, pressure of tumors, venous congestion, &c. may prevent re-absorption. Hence, dropsy a symptom in organic disease of Liver, Heart, Kidney, Ovary, &c., and in exhaustion from protracted diseases, especially Phthisis; (explain.) Indications according to the proximate cause in each case—explain. Uncertain action of Diuretics administered to remove Ascites, &c.; how explained.

Serous Secretions, how modified by Inflammation of Serous membranes? Its peculiar effects on these membranes themselves, (p. 9.)

Serous accumulations in abnormal positions; Serous Cysts, &c. Serous surface itself must be removed; or the cavity obliterated; how?

II. LACHRYMAL FLUID.

Structure of the Lachrymal gland; its ducts. This secretion intermediate between Serous and Mucous fluids—explain. Its physical properties. Chemically, it resembles the Aqueous Humor (Fourcroy and Vauquelin); the principal solid (are but 1

per cent. in all) is Chloride of Sodium. Hence the expression "briny tears."

Uses of this secretion—Effects of its non-seeretion; do. of excessive do., (Epiphora). Is affected by mental emotions, of various kinds. How explained?

III. *The Fluids aiding Digestion* have already been considered; Saliva (p. 13)—Gastric Fluid (p. 14)—Pancreatic do. (p. 15)—Bile (p. 15 & 37).

IV. All the *Mucous Fluids* (except of alimentary canal) seem to be pure Secretions. (See p. 16 & 37.)

V. FATTY FLUIDS.

Found, (except Adipose tissue and Marrow), on external surfaces; and are evaporated in great part, (not re-absorbed.) Peculiar adaptation of such fluids to free external surfaces. For chemical constitution of fatty organic Elements, see p. 10.

A. *Adipose tissue* (fat)—its peculiarities (p. 11). How is fat secreted? Size and arrangement of fat cells. Their secreting function and their nutrition, identical;—explain—(see also p. 35.)

The several uses of the Fat. Average quantity in adults, in proportion to whole weight. Difference in the sexes, and at different ages, in this respect. Individual peculiarities. Instances of excessive secretion of Fat (Polysarcia)—Do. of an opposite character (Marasmus). Peculiarities of tribes, and of nations even, in these respects—illustrate.

The secretion of fat liable to sudden fluctuations in amount. This first disappears during sickness, (and starvation) being also first to reappear during convalescence; why? Sometimes is a progressive and somewhat rapid emaciation (absorption of fat) during the first few days of convalescence—how explained (see p. 17 and 18)?

Do corpulent persons endure privation of sleep better than the lean?

Fat is often found in abnormal positions; e. g. fatty tumors, of various kinds. These always non-malignant. Its normal quantity often increased in internal organs, constituting fatty degeneration; e. g. of Liver, Kidneys, and Lungs. All these indicate diminished Aeration by the Lungs; hence present in Phthisis, &c., &c. (Guillot)—see also p. 29, 2d; and 38.

B. *Marrow of Bones.* Not found in young bones; why? Not in those of birds of flight, why?

Uses of the marrow in human bones.

C. *Sebaceous fluid of the Skin*—Structure of the Sebaceous follicles. Fluid differs in different parts of the body; proofs. Odor of perspiration principally derived from it (p. 38). Glandulæ odoriferæ of axilla (Horner)—do. of glans penis.

Chemical composition of this fluid (Esenbeck); contains Stearine, Albumen (each 242 in 1000); Phosphate of Lime (200 in 1000), &c.

Uses of sebaceous fluid. Effects of its non-secretion, or its entire removal from the skin. Is changed in certain diseases—explain. Is affected by mental emotions?

D. *Meibomian fluid.* Structure of Meibomian glands. This fluid is intermediate between mucous and fatty fluids; consisting of mucous matter and fat (Simon).

Uses of this fluid. Effects of non-secretion, and of vitiated secretion. Indications.

E. *Cerumen of the Ear.* Its physical properties. Chemical composition (Simon); contains fat, albumen, epithelium scales, &c.; but no chlorides nor phosphates soluble in water. Its uses. Why its disagreeable odor? Effects of non-secretion; do. of change in its character. Indications.

VI. FLUIDS SECRETED BY THE SEXUAL ORGANS.

All the fluids of the Male, and Milk also, are re-absorbed, if not excreted from the body; if excreted, are absorbed by another individual—this being the final cause of their secretion; explain. The Catamenial secretion is immediately excreted; or if retained, is not reabsorbed—the Germinal fluid is also to be excreted either at once, or at the end of gestation. Explain. Both these secretions have peculiar physiological relations, and are in these respects *sui generis*.

A. *Fluids of the Male.*

1st, *Semen*—Minute structure of human testis. Physical properties of semen—Appearance under the Microscope—Describe the Spermatozoa. Their different forms and sizes in the various classes of animals. Are they actual animalculæ?

Chemical composition of Semen (John); the water ($\frac{9}{10}$ of the whole) contains Phosphate of Lime, Chloride of Sodium, &c., and a substance resembling Mucus.

Uses of Semen—is the *germ-vivifying* agent (see Reproduction). Average quantity excreted at a time. Much affected by mental states; explain. Age at which the secretion is first produced; do. when it ceases. Ruinous effects of habitually excessive excretion of this fluid. Remarks on the habits producing this result. How best removed? How remove their effects? Why matrimony produce a cure, while illegitimate indulgence cannot? Proofs of this proposition.

2d. Fluid secreted by *Vesiculæ Seminales* is probably Mucus. Structure and uses of the Vesiculæ—not found in all animals, why? The *Prostatic* fluid has never been analyzed—resembles Mucus. Its uses. Structure of the Prostate. Probable uses of the fluid secreted by *Cowper's glands*.

B. *Fluids of the Female.* Have all a mutual relation, and all a direct relation to the Function of Reproduction. The Catamenial and Germinal fluids are produced simultaneously with each other;—the Milk subsequently, but never at the same time. The Mammary gland sometimes *vicariously* (explain) secretes the Catamenial fluid, but never during lactation.

1st, *Catamenial fluid.* By what secreted? A periodical secretion; explain. Physical characters—Chemical composition (Simon, and Denis); compared with blood. Does it contain any fibrine (Simon; Day)?

Average quantity secreted at each period—Affected by mental states, &c. Average age at which the secretion appears; and ceases. Effects of climate, social position, &c., in this respect. Duration of each period.

All the Mammalia have the Catamenial discharge; proofs. Difference in the period, in each species; the term of gestation always being a precise multiple of it—illustrated. Will this apply to *individuals*, as well as different species?

This fluid is *peculiar* in the following respects. 1st, It is rather an *extravasation* (capillary hemorrhage) than a secretion, in respect to the manner of its production, and its composition—explain. 2d, It has not, like other secretions, a definite use; farther than to aid in the excretion of the detached (but unimpregnated) ova, and the uterine and vaginal mucus, which is always combined with it. 3d, It has sometimes an *acid* reaction (Rindskopf). 4th, Is immediately excreted, unlike the other proper secretions; though it does not remove a deleterious element from the blood, like the proper Excretions.

Physiological relations, &c. The *effects* of the periodical discharge of this fluid appear to be precisely those of an habitual hemorrhage. Explain. It relieves the periodical Hyperæmia of the Uterus and its appendages; which appears to be its primary object.

The following seem the ultimate facts: 1st, A reproductive *nisus* (explain) recurs in the ovaries and uterus at each period, accompanied by a state of hyperæmia of these organs. 2d, The ovaries produce germs (ova), and the Uterus pours out an organizable fluid (very nearly pure blood). 3d, This relieves the hyperæmia, and aids the excretion of the ova, &c., if not impregnated—or becomes organized into one of the fœtal membranes, (explain) if the ovum is destined to undergo farther development in the Uterus. Proofs of this view.

The *appearance* of the Catamenial discharge is therefore merely a *sign* of the previous development of a germ; though its absence does not always disprove such development—explain. In ordinary menstruation, then, this is a mere habitual hemorrhage in its results and effects. In impregnation it finally becomes an organized membrane. This sometimes also occurs in cases of Dysmenorrhœa—explain. Ordinarily the mixture of vaginal

mucus with its fibrine, destroys the coagulability of the latter; hence fibrine not usually detected in the Catamenial discharge. The development of a germ (ovum) renders impregnation possible; and, with the *sign* above-mentioned, and a simultaneous development of all the sexual organs, mammary glands included, constitutes Puberty. Other interesting moral changes which characterize this epoch in the female.

Pathological relations, &c. Effects of non-secretion of the Catamenial fluid.

1st, May not appear at the usual age, or cease before the usual epoch, because no ova are developed. Here the *cause* of non-development (some insidious disease perhaps, or mere debility) requires attention; *not* the Amenorrhœa.

2d, Sudden suppression of the discharge, from exposure to cold, shocks to the nervous system, &c. Here the consequences are those of the sudden arrest of an habitual hemorrhage; and from the extensive sympathies of the organ implicated, may suddenly be even fatal. Indications.

Action of Emmenagogues—Tonics are the only valuable ones in the 1st class of cases above; the Sediluvium, Venesection, Cathartics, &c., &c., in the last.

2d, The *Germinal Fluid*—i. e. the fluid contained in the germ, or Ovum. See structure of ovum, p. 53.

3d, The *Liquor Amnii*—secreted within the Uterus by the fœtal membranes. See Serous secretions, p. 45.

4th, *Milk*—Structure of the Mammary gland. The characters of Milk vary at different periods of its secretion.

A. *Colostrum* (define)—Its physical and microscopical characters—its peculiar corpuscles (Donne). Chemical composition—Has more of all the solids than ordinary milk, except Caseine. Its peculiar effects on the infant. For how long time secreted?

B. *Ordinary Milk*—Its physical properties—Microscopical do. Specific gravity. Consists of water holding in solution sugar of milk, caseine, and certain salts; and in *suspension*, an oily matter (cream). How does butter differ from cream? How separate each of these four constituents? Human milk retains its alkaline reaction longer than that of lower animals (5 or 6 days even). The following is Clemm's analysis of Milk, 9 days after delivery.

Water,			885.818
Butter,	35.316		
Caseine,	36.912		
Sugar of Milk, and Extractive matter,	42.979	Solid constituents.	114.182
Salts, of various kinds,	1.691		
			1000.

But composition varies in females of different temperament—specify (L'Heritier)—Do. from long remaining in the breast. Changes produced by diet; poor diet may reduce the solids to 86 in 1000 (Simon); the sugar and caseine being hardly changed at all, while the butter is very much reduced. Composition also varies with the time subsequent to delivery; being least Caseine and most Sugar at first; while the butter constantly varies. Last is also diminished by any cause producing active Aeration, why? Milk returns to its colostral character at the end of about a year—Inference.

1. The *oily* portion of the Milk (cream) containing the Butter, consists principally of Elaine and Stearine (p. 10, 3d), and also contains Butyrine (its formula) which yields butyric, caproic and capric acids.
2. The *Caseine* of woman's milk is less easily coagulated than that of the cow's, and is less in quantity. Even mineral acids and the acetic, often fail to precipitate it, but rennet always slowly effects this. Properties of Caseine, &c. (p. 8.)
3. The *Sugar of Milk* (p. 10) is nearly identical, chemically, with starch, and like it, converted into true sugar by Sulphuric acid. Its formula. Is converted by any *ferment* (p. 9) into Lactic acid; e. g. by rennet, or the Caseine itself, if decomposing. This acid then precipitates the caseine, how?

Much less sugar in cow's milk than in woman's. Hardly a trace of sugar in that of the Carnivora, why?

4. The *Salts* of human Milk are nearly identical with those of the blood; being more phosphates—1st, *(Insoluble)* Phosphate of Lime, and Magnesia, Carbonate of Lime, and a very little Phosphate of Iron, &c.—2d, *(Soluble)* Chloride of Sodium and Potassium, Chloride of Calcium, Carbonate of Soda, Sulphate of Potassa, &c. (Simon.)

Physiological relations, &c. Is sole nutriment of infant during first months after birth. Its perfect adaptation to this end; most of all secretions, resembles blood in composition—and contains the nutritive and calorific elements in the required proportion (p. 17, top). Explain the uses of its various constituents to the infant.

How make for the infant, a substitute for woman's milk, from that of the cow? How vary this for adults; why?

This secretion modified in quantity, and *quality* even, by mental emotions; how explained? The "draught."

Pathological relations of this fluid.

Effects on the female, of non-secretion of milk, after delivery. Do. of retention in the breast, and partial re-absorption. Do. of excessive lactation; their Protean character. Do. on the infant, of prolonged lactation. How long (average) should lactation continue?

Milk is sometimes secreted by the male (Prof. Dunglinson). Chan-

ges induced in the Milk by diseases, by mental emotions, &c., &c.; see Simon's Chemistry of Man, p. 337, &c.

Certain medicinal substances are eliminated in the milk, especially saline compounds; also oxyd of zinc, tris-nitrate of bismuth, &c. But vegetable cathartics, do not enter it; as castor-oil, senna, colocynth, &c. Therapeutical inferences.

But certain remedies have been detected in the Urine of the infant, which cannot be in the mother's milk—e. g. mercurial medicines, Iodide of Potassium, &c. But Herberger detected the latter in milk also.

For the characters of the *Lochial* secretion, see the best modern works on Obstetric Medicine.

VII. FUNCTION OF REPRODUCTION.

GENERAL REMARKS.

The preceding Functions secure the development, &c., of the *individual;* this, the perpetuity of the *species.* Are various modes of effecting this in the animal series.

1st, The *Gemmiparous*—explain and illustrate.

2d, The *Fissiliparous*— " "

Neither of these requires the distinction of sex, nor distinct Reproductive organs.

3d, The *Sexual* mode—explain. Three varieties:

A. Hermaphrodism (explain); and *self*-impregnation; illustrate.

B. Do. — still 2 individuals are required, and effect a *mutual* impregnation.

C. Sexes in distinct individuals, and two of opposite sexes necessary for impregnation.

This mode requires a germ-*producing* organ, the *Ovarium* in the female; and in the male, the *Testis*, secreting the germ-*vivifying* fluid (the Semen).

All animals of distinct sexes are Oviparous, or Viviparous. Explain.

The *Oviparous* may expel the Ova, (1.) before they come into contact with the male fluid (e. g. fishes and some reptiles); or (2.) soon after (e. g. birds). In both cases merely an Oviduct (explain) is superadded to the Ovary in the female. In the 1st case, the male organs are merely the Testes with their excretory ducts extending merely *to* the surface of the body; in the 2d, the latter must be extensible *beyond* the surface—for in (1) actual copulation does not occur; in (2) it is indispensable to reproduction.

In *Viviparous* animals the excretory canal in the male must also be extended for the same reason. Here the phenomena of the Reproductive process always occur in the following order:

1st, Development of ova by the Ovary of the Female.
2d, Their vivification by the male fluid during Copulation (Coitus).
3d, Subsequent development internally, of the vivified ovum, or *Embryo*, (Gestation).
4th, Final expulsion of the developed embryo, or *Fœtus*, (Parturition).

These successive stages require in the female 1st, The Ovaries—2d, (Fallopian tubes) passages from them into 3d, A Uterus, in which the embryo becomes fully developed. 4th, A canal thence to the exterior—the Vagina. These remarks apply to all the Mammalia.

REPRODUCTION IN THE HUMAN SPECIES.

Structure of the Reproductive organs of the male (see also p. 48). Do. do. of the Female. Functions of each organ.

I. The part performed by the *Male* towards Reproduction consists merely (1) in producing the Semen, and (2) so excreting it during coitus as to effect its contact with one or more mature ova. This last is a *dynamic* action (see Reflex Motion); usually accompanied by vivid sensory impressions also; but not necessarily even by consciousness. Coitus always, with the male, a voluntary act. The term "impregnation" is applied properly to the female; and Fecundation or Vivification to the ovum—explain. The Spermatozoa are the fecundating portion of the Semen (p. 48). Their number in a drop of this fluid.

How and where do the Spermatozoa come into contact with the ova? How long a time necessary for this after their excretion?

II. The *Female* has the following parts to perform:
A. The development of Ova.
B. Conception—define—as a result of coitus.
C. Intra-uterine development of the Embryo (Gestation).
D. Final expulsion of fœtus; (Parturition, or Delivery).
Each of these will be separately considered.

A. *Development of Ova.* Occurs with the Catamenial discharge, at Puberty (p. 50). The structure of the ovum, according to Wagner, Dr. Barry, Bischoff, and others. Its size, contained fluid, &c. Are ova matured and discharged with each catamenial discharge? "Corpora lutea," define—Distinction of true and false.

B. *Conception*—a mere *passive* result of coitus, so far as the female is concerned (explain). Does not necessarily imply a consciousness of the latter even; which is therefore not necessarily voluntary in the female. Proofs. What are the circumstances essential to conception? Hence impossible to distinguish, at once, a fecundating from a non-fecundating coitus. *Early signs* of Conception (Pregnancy). At what time during the Cat-

amenial cycle is conception most frequent? Researches of Dr. Ritchie, Raciborski, &c.

Changes occurring in the ovum immediately after fecundation. How long in traversing the Fallopian tubes? and what force produces this result? Changes meantime occurring in the Uterus to prepare it for the reception of the Embryo. Extra-uterine fœtation; Super-fœtation—define.

C. *Gestation*—its duration (p. 49). Causes extending its ordinary duration (Earl Spencer)—Its shortest duration compatible with life of the fœtus. Usual period of "quickening" (define). Why may not conception occur *during* gestation? What is abortion? Miscarriage, &c.?

Structure and functions of the fœtal membranes—the Liquor Amnii (p. 45, C). Structure of the Placenta—its peculiar connection with the Uterus—its Functions. Can the mental states of the mother directly affect the fœtus? Explanation of cases seeming to prove this to be the fact?

For the whole subject of Development of the Embryo and the Fœtus in Utero, see p. 11. (Baer, Lee, &c.)

Monsters (define) how accounted for. Geoffroy St. Hilaire's theory of arrest of development. Illustrate at length.

D. *Parturition*—a dynamic function (see Reflex motion). Its average duration. Ratio of male and female births; how accounted for?

For the Mechanism, and the practical bearings of this function, consult the standard works on Obstetric Medicine.

After Reproduction is completed, the female still provides nourishment for the infant—Lactation. For the properties of Milk and other topics under this head, consult p. 50, &c.

Recapitulation of all the Organic Functions, showing their correlations and mutual dependence; and their relations to the Animal Functions next to be discussed.

END OF FIRST PART.